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1651/67.

SURVEY

OF THE

Wisdom of GOD in the CREATION:

OR A

COMPENDIUM

OF

Natural Philosophy.

IN THREE VOLUMES.

VOL. III.

These are thy glorious Works, Parent of Good,
Almighty! Thine this universal Frame,
Thus wondrous fair! Thyself how wondrous then!

MILTON.

BRISTOL:

Printed by WILLIAM PINE, 1770.

SURVEY

OF THE
WISDOM OF GOD IN HIS CREATION:

OR A

COMPENDIUM



NATURAL PHILOSOPHY.

IN THREE VOLUMES.

VOL. III.

These are the persons who have been
employed in the execution of this
work, and who have been
employed in the execution of this
work.



BRISTOL:

Printed by WILLIAMSON & CO.

APPENDIX.

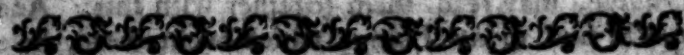
PART. II.



APPENDIX

PART II





R E A R.

1. **A** Few Years ago, when I ventured to publish a little Sketch of Natural Philosophy, I had no Thought or Design of ever going any farther, or making any Additions to it. But the favourable Acceptance which it met with, so far beyond my Expectation, encouraged me, at my leisure Hours, to look farther into the Subject, and to set down whatever, from Time to Time appeared most worthy of Observation.

2. My first Design was, in the next Edition of the Book, to insert in their proper Places additional Notes, to correct, to explain, or to enlarge upon, what had been before delivered. But on Reflection, I feared this might give Disgust to the Purchasers of the former Edition. It seemed therefore more advisable, to throw them all together, in the Form of an Appendix: By which Means these might have equal Advantage, with the Purchasers of the latter Edition.

3. But as I went on, the Work grew upon my Hands, so that an Appendix soon swelled into a Volume. Yet still it seemed best, to refer every Article in this to its proper Place in the preceding Volumes.

Volumes. Whoever therefore chuses to take that Trouble, may read them together with this; And he will find many Things which occur there, here placed in a clearer or stronger Light. But if any prefer the Reading it all together, it may not be lost Labour. Only let them remember, This Volume alone is not a System of Natural Philosophy, but barely a Collection of Philosophical Experiments and Observations.

4. One Use which a serious Reader may make of this as well as the preceding Volumes, is to fix in himself a fuller and deeper Conviction of the Wisdom of God and the Ignorance of Man. For all the additional Light which we here receive, touching the wonderful Works of God, is an additional Proof, how small a Part of his Ways we are able to understand. Let us praise him however for what Knowledge we have; which small as it is, yet is an invaluable Treasure: Especially when it's directed to its proper End, the Knowledge of Him, whom to know is Life eternal!





Part First.
CH. R. B. V. I.

Of the Structure of the Human Body.

- | | |
|--------------------------------------|---|
| 1. The Nature of a Cartilage: | 11. The Structure of the Nose: |
| 2. The Nutriment pervades the Bones: | 12. A Person speaking without a tongue: |
| 3. Use of the Lymphatic Vessels: | 13. Persons deaf and dumb taught to speak: |
| 4. A Boy with a dappled Skin: | 14. Dumbness suddenly removed: |
| 5. Structure of the Pores: | 15. The Hair turned white through Fear: |
| 6. Queries concerning Perspiration: | 16. Through Grief. |
| 7. Queries concerning the Eyes: | 17. White Hair: triangular: |
| 8. Peculiarities relative to them: | 18. Voice in common Discourse all Concorde: |
| 9. Help for decayed Sight: | 19. An Old Woman giving suck: |
| 10. Account of a Person couched: | 20. Account of a Man without arms. |

V. I. p. 18. **A** Cartilage is an elastic Substance, uniformly compact and somewhat transparent, harder and more brittle than a Ligament, softer than a Bone. It is covered with a fine Membrane, a
Continuation

Continuation of that which lines the Capsular Ligament, folded over the Bone, from where the Ligament is inserted. Every Joint is inserted with a Membrane, which forms a complete Bag, and covers every Thing within the Articulation. The Blood-vessels are so small, that they do not admit the red Globules, and are demonstrable only in very young Subjects. All round the Neck of the Bone, there are numerous Arteries and Veins which ramify into smaller Branches, and communicate with each other. These divide into still smaller Branches, on the adjoining Surface, as they run toward the Center of the Cartilage. We can seldom trace them into its Substance, because they end abruptly, at the Edge of the Cartilage. The larger Vessels, plunge in by numberless small Holes, and disperse themselves into Branches between the Cartilage and Bone. From these again there arise many short, small Twigs, which shoot toward the outward Surface. This Distribution of the Blood Vessels is very peculiar, and calculated for obviating great Inconveniences. Had they run on the outward Surface, the Pressure and Motion of the two Cartilages must have occasioned frequent Obstructions and Inflammations. But by creeping round the cartilagenous Brim, where there is little Friction, or under the Cartilage, where there is none, they are perfectly well defended from all such Accidents.

Cartilages are admirably contrived for all the Purposes of Motion. By their uniform Surface they move upon one another with Ease: By their soft, smooth and slippery Surface, mutual Abrasion is prevented. By their Flexibility the contiguous Surfaces are constantly adapted to each other. By their Elasticity, the Violence of any Shock, which might happen in running, jumping, or the like, is broken, which must have been extremely pernicious, if the hard Surfaces of Bones had been immediately contiguous. The cartilagenous Fibres appear calculated chiefly for this last Advantage. To conclude, the Insensibility of these Cartilages is no less wisely designed, that by this Means the



the necessary Motions of the Body may be performed without Pain.

V. I. *ibid.* That the Nourishment taken in, is continually conveyed through the *Bones*, as well as the *Flesh*, appears from an easy Experiment. Mix any red Liquor with the Food of any Animals, and in a short Time, their Bones are died red. When Mad-deder Root was mixt with the Food of a Cock, which died after sixteen Days, all his Bones were red, the internal Parts as well as the external. And the most solid Parts were the most deeply tinctured: In Swine, the Teeth above all the rest.

V. I. p. 21. It has been lately discovered, that the *Lymphatic Vessels* have two Coats, betwixt which there are innumerable fine Filaments without any Valves, containing a nutritious Juice, which is conveyed into all Parts of the Body, by a Motion from the Centre to the Circumference, and returns through the inner Pipes, (furnished with Valves) of the same watry Vessels. But this Juice when returning is no more Water or Dew, but Ferment, and the Vessels may be termed Ferment-Vessels. This Ferment is conveyed into the Blood, by a Motion from the Circumference to the Center.

The Lymphatics carry their dewy Particles through the Glandules, which lie between the two Coats. In the lowermost End of these Glandules, the Ferment-Vessels take their rise. Most of the Juice of the Lymphatic-Vessels is discharged between the Coats of the Veins, Arteries, and Vessels, in the Mesentery, to be conveyed into all the Parts of the Body, both internal and external. Even in bearing Females the Fruit is not nourished by Blood, but by this nutritious Juice: The remaining Part of which, is transmitted into the Blood through the thoracic Duct and jugular Veins.

P. 23. Who can account for the following Case? Sir Charles Wager had a Boy about eleven Years old, who
was

was born in *Virginia*, of Negro Parents. Till he was three Years old, he was like other black Children. He then, without any Distemper began to have little white Specks, upon his Neck and Breast. These increased with his Years, both in Number and Bigness, so that from the upper Part of his Neck, quite down to his Knees, he was dappled with white Spots, some of them broader than the Palms of a Man's Hand. They were wonderfully white, equal to the Skin of the fairest Lady, only somewhat paler. His Face, Arms and Legs, were perfectly black. He was exceeding active, sprightly, and more ingenious, than is common among that Generation.

The Pores in our Hands and Feet are very remarkable. Survey with a Glass the Palm of your Hand well-washed, and you may perceive innumerable little Ridges, of equal Bigness and Distance, every where running parallel with each other: These are very observable on the Ends and first Joints of the Fingers and Thumb; and near its Root, a little above the Wrist.

On these Ridges stand the Pores, all in even Rows. Through a good Glass every Pore looks like a Fountain. The Sweat may be seen to stand therein, as clear as Rock Water. The Ridges are so placed, that they may better suit with the Use and Motion of the Hand: Those on the lower Side of each Triangle, to the Bending-in of the Fingers: Those on the other two Sides, and on the Elliptic Ridges, to the Pressure of the Hand or Finger Ends, against any Body, requiring them to yield to the Right and Left.

The Pores are placed on these Ridges, not in the Furrows between them, that their Structure may be less liable to be injured by Compression, whereby the Furrows only are dilated or contracted: The Ridges constantly maintaining themselves; and so the Pores are preserved. For the same Reason the Pores are very large, that they may be the better preserved; though the Skin be never so much compressed and condensed, by the constant Labour of the Hand: And so those on the Feet, that they may be preserved, notwithstanding the Compression of the Skin, by the Weight of the whole Body.

Perhaps

Perhaps the following Fact is no less difficult to be accounted for. A Negro Woman, Cook to Colonel Barnes, in Maryland, about forty Years of Age, remarkably healthy, had her Skin as dark as that of the most swarthy African. But that Part of it next her Finger Nails, about fifteen Years ago, became white. Her Mouth soon underwent the same change, which has since gradually extended over the whole Body. At present four Parts in five of her Skin, are white, smooth, and transparent, as in a fair European, elegantly shewing the Ramifications of the subjacent Blood-vessels. The other Parts daily lose their Blackness, and partake of the prevailing Colour. The Neck and Back retain most of their prestine Hue; the Head, Face, Breast, Legs and Arms are all white. Her Face and Breast, when Anger or Shame has been excited in her, have been immediately observed to glow with Blushes. This is the naked Fact; but upon what Principles of Philosophy can we account for it?

V. I. p. 24. Some Queries proposed concerning Perspiration by an ingenious Writer, seem to deserve a serious Consideration. 1. "Why do carnivorous Animals sweat so little? A fox hunted almost to Death never sweats. 2. Why do those which feed on Vegetables perspire so much? Horses and Cows, for Example. We may often see them involved in a Cloud of their own Vapours, yea, almost covered with Froth. 3. How can Animals, whose natural Food is Vegetables, be kept alive and in Health in very cold Climates, by purely animal Food? Cows in *Iceland* and in *Norway*, are fed in Winter upon Fish bones." I would beg leave to ask, 4. Do the Sweat-pores only, insinuate? Or those also which serve for insensible Perspiration?

P. 28. The *Reindeer* has over his Eye-lids a Kind of Skin, through which he sees a little; otherwise in the hard Snows, he would be obliged to shut his Eyes intirely.

This

This therefore is a singular Instance, of the Wisdom and Goodness of God.

V. I. p. 32. I would beg leave to propose a few Queries here, to which I have not found a satisfactory Answer.

1. Why do we see Things *false* with one Eye? Particularly, with regard to their Situation.
2. How do the two Eyes *compound* the Rays of Light, so as to see right?
3. Why do we not see all Things *double*?
4. Since all Things are painted *upside down* on the Bottom of the Eye, why do we not see them so?

Vol. 1. 32. Some odd Circumstances relative to the Eyes, are related by a Physician in the *Philosophical Transactions*.

"A Person had no visible Disease in his Eyes; yet could not see, unless he squeezed his Nose with his Fingers, or saddled it with narrow Spectacles, and then he saw very well.

"A Maid, 23 Years old could see very well, but no Colour, beside white or black: She could sometimes, in the greatest Darkness, see to read almost a Quarter of an Hour.

"A Saddler's Daughter had an Imposthume, which broke in the Corner of her Eyes. And out of it there came about thirty Stones, as big as small Pearls".

"A young Man in *Suffolk*, about 20 Years of Age, has all the Day a clear and strong Sight. But when Twilight comes, he is quite blind; nor can he see any Thing at all, either by Fire-light or Candle-light. No Glasses give him any Help. He has been thus, ever since he can remember. This Cloudiness comes gradually upon him, like a Mist, as Day-light declines. It is just the same, both in Summer and Winter, and at all Times of the Moon.

"When I was about Sixty, my Sight was so decayed, that I could not distinguish Men from Women. I received no help from any Glasses, till I took Spectacles

cles with the largest Circles. Close to the upper Semicircle on both Sides, I cut the Bone, and taking out the Glasses, put black Spanish Leather taper-wise into the emptied Circles. These took in my whole Eye at the wider End, and through the narrow End I can read the smallest Print. Into this End I can only put my little Finger, not quite to the first Joint. But they may be made wider or narrower, and longer or shorter, as best fits every Eye.

"At first I could not bear them above two Hours at a Time: Now I can use them above twelve Hours in four and twenty. And they prove a great Help, to those who are purblind, who have weak Eyes, or decayed with Age. But for the Purblind they must be made shorter; longer, for Eyes decayed with Age.

"Instead of Leather, they may be made of Paper, coloured black and pasted on; and with inner Folds to be drawn out, from one Inch to three."

V. I. p. 33. An Extract from Dr. *Cheffelden's* Account of a Person couched, will not be unacceptable to the curious.

"This young Gentleman could in a strong Light distinguish black, white, and scarlet. Yet the faint Ideas he had of them before he was couched, did not suffice to make him know them after. He now thought Scarlet the most beautiful of all Colours. Of others, the most gay were the most pleasing. But the first Time he saw black, he was very uneasy; yet after a while he was reconciled to it. When he first saw no Objects were so agreeable to him, as those that were smooth and regular. Although he knew not the Shape of any Thing, nor could distinguish one from another, either by its Shape or Size. Being told, what those Things were, whose Forms he knew by feeling, he would carefully observe, that he might know them again. Thus having often forgot, which was the Cat, and which the Dog, he was alarmed to see. But catching the Cat, (which he knew by feeling) he looked at her steadfastly, and said, "So, Puss, I shall know you another Time." He was surprized, that

the Things or Persons he liked best, did not appear most agreeable to his Sight; expecting that what was most pleasing to his other Senses, would be so to his Sight also.

We thought he soon knew the Nature of Pictures, but found afterward we were mistaken: For it was two Months after the Operation, before he discovered, that they represented solid Bodies. Even then he was no less surprized, expecting they would feel like the Things they represented. He was amazed, that those Parts, which by their Light and Shade appeared round and uneven, should feel like the rest, and asked, Which was the *Lying Sense*; feeling or seeing? Being shewn his Father's Picture drawn in Minature, and told, what it was, he acknowledged the Likeness; but asked, how it could be, that so large a Face should be contained in so little Room? Saying, it would have seemed as impossible to him, as to put a Bushel of any Thing into a Pint. But even Blindness he observed, had this Advantage, that he could go any where in the Dark, better than those that could see. And after he was couched, he did not lose it, but could go all about the House without a Light. Every new Object gave him new Delight, such as he wanted Words to express. He was particularly delighted when he first saw a large Prospect, and called it, a new Kind of seeing. Being afterwards couched in his other Eye, he said, that Objects appeared larger to this Eye; though not so large as they did to the other, when it was newly couched. But looking on them with both Eyes, they seemed twice as large, as if he looked with that only."

P. 36. Each of the *cartilaginous Laminae* is divided into many others, folded into a spiral Line. The *Or cribrosum* is made up of the Extremities of these; the Holes therein being the Intervals between them. They are designed to uphold the inner Tunic of the *Nose*, which is folded round about together with these *Laminae*, that by its great Expansion it may receive

a greater Number of the odorant Particles. For the same Reason, it is furnished with many small Glands, which open into it, and moisten it with a slimy Exudation, fitted to intangle and detain the subtile Effluvia that touch it.

And not only the Number, but also the Length of these Laminæ, is of great Use for the Strength of smelling. For this Purpose most Beasts which either hunt, or distinguish their Food by Smell, have not their Nose in the Middle of their Face, like Man, but prolonged to the very End.

V. I. p. 39. It has been generally supposed, that the Tongue is essentially necessary to the Formation of Speech. But as sure as we have been of this, it is an entire Mistake. A Child in *Essex* some Years ago, had her Tongue entirely cut out, by Reason of an incurable Canker. She was then three Years old. Twenty Years after, it was reported, that she was able to speak: To be satisfied hereof, Mr. Benjamin Boddington, Turkey-Merchant of *Ipswich*, with two other Gentlemen went to *Wickham-Market*, where the young Woman then lived, whose Case they thus describe.

"We have this Day been at *Wickham Market*, to satisfy ourselves concerning *Margaret Cutting*. We examined her Mouth with the greatest Exactness, but found no Part of the Tongue remaining; nor was there any Uvula. The Passage down the Throat is a circular, open Hole, large enough to admit a small Nutmeg.

"Notwithstanding this, she swallowed both Solids and Fluids as well as we could do, and in the same Manner. Yea, and she talked as fluently as other Persons do. She pronounced Letters and Syllables very articulately, even those which seem necessarily to require the Help of the Tongue, as *d, l, t, w*. She read to us in a Book distinctly, she sings very pleasantly, &c. and she distinguishes Tastes, and can tell the least Difference either in Taste or Smell."

But is it possible to teach any one to speak, who has been *deaf and dumb* from his Birth? It is, Dr. Wallis taught such an one to speak, Mr. Daniel Whaley of Northampton. He was present before the Royal Society, May 21, 1662, and did there pronounce distinctly enough such Words as the Company proposed to him: Indeed not altogether with the usual Tone, yet so as easily to be understood. In a Year, which was the Time he stayed with Dr. Wallis, he read over great Part of the English Bible, and learned to express himself intelligibly in common Affairs, to understand Letters written to him, and to answer them. And in the Presence of many Foreigners, he has not only read *English* and *Latin* to them, but has pronounced the most difficult Words in their Languages, which they could propose to him.

The Doctor has since done the same for Mr. Alexander Popham, a Gentleman of a fair Estate.

But we have an Instance of *Dumbness* cured in a shorter Time. Henry Axford, Son of Henry Axford, in the *Deviſes*, at 28 Years of Age, perceived an Hoarseness, and in about six Days became quite Speechless, not only unable to speak articulately, but to utter the least Sound with his Tongue. His Cold went off, but he remained absolutely Speechless; and the Advice of all the neighbouring Physicians did not help him.

He continued totally dumb for four Years, till in July 1741, being at Stoke, in returning homeward at Night, he fell from his Horse, and was taken up and put to Bed in an House upon the Road. He soon fell asleep, and dreamed, he was fallen into a Vessel of boiling Wort. Struggling with all his Might, to call for Help, he actually did call aloud, and recovered the Use of his Tongue from that Moment, as perfectly as ever he had it in his Life.

Perhaps therefore there is Truth in that ancient Story, concerning the Son of King *Craſus*, namely, having been dumb from his Birth, he had never spoke at all, till in the Battle, seeing a Man ready to kill

him, he called out, and was heard, and so recovered his Speech.

kill his Father, his Tongue was loosed, and he cried out aloud, "Soldier, spare the King."

V. I. p. 40. Extreme Fear may turn the Hair grey or even white in a short Space. So it was in that famous Instance some Years ago: A Noblesman in Germany was condemned to die, and ordered for Execution in the Morning. During the Night, in ten or twelve Hours Time, all his Hair turned white as Flax. The Emperor being informed of this, said, "He has suffered enough," and pardoned him.

Since that Time there has been an Instance of one of our own Country-men, who being ship-wrecked, saved himself on a small Rock, surrounded by the Sea. A Boat took him off, after he had stayed there four Hours. But in that Space, his Hair was turn'd quite white.

Perhaps a still stranger Instance of this Kind, is related in the Duke of Sully's Memoirs, "*Henry IV.* told the Marquis *de la Force*, That the Moment he was informed, *Henry the III.* had published an Edict, (in July, 1585) ordering all the Huguenots either to go to Mass, or to abandon the Kingdom in six Months, his Mustaches turned suddenly white on that Side of his Face, which he supported with his Hand."

V. I. p. 41. Many white Hairs appear triangular, even to the naked Eye. Are all grey and white Hairs so? How do they appear thro' a good Microscope?

Are Hairs minute Horns? Are they a Medium between Horn and Flesh? Or do they rather belong to the Vegetable Kingdom?

P. 45. With regard to the Human Voice, an ingenious Man observes. "Sitting in Company I chanced to take Notice, that in ordinary Discourse, all that is spoke, is spoken in perfect Notes; and that some of the Company used Eights, some Fifths, and others

Thirds. I observed likewise of him whose Speech was the most pleasing, that all the Tones he used, consisted either of Concords, or of such Discords as made up Harmony.

P. 47. "One informing me of an *old Woman that gave suck*, I went to the House in *Tottenham-court Road*. Her Name is *Elizabeth Bryan*. She is in the 68th Year of her Age, and has not borne a child for many Years; her Face is withered, her Cheeks and Mouth sunk in; but her Breasts are full, fair and void of Wrinkles. About four Years ago, her Daughter was obliged to leave an Infant she gave suck to, in the Care of her Mother. The old Woman finding the Child froward for want of the Breast, applied it to her own. Having done this several Times, her Son thought the Child seemed to swallow, and begged his Mother, he might try, if she had not Milk? It soon appeared she had; and she then continued to suckle the Child in Earnest. Two Years after her Daughter had another Child; on which the Grand-mother weaned the First, and suckled the Second. Both the Children are healthy, plump and firm in Flesh, and as brisk and lively as can be desired.

P. 51. Is there any possibility, that the want of so necessary an Instrument as the Arm should be supplied? One would think, it impossible. But it is not: Such is the amazing Power of God! *James Walter* was born in 1718, in *Ireland*, in the Parish of *Hilborough*. His Mother could not be delivered, till the Surgeon totally separated the Arms of the Child from the Body. Nevertheless he lived, and in the room of his Arms, had little Protuberances that appeared as Stumps. He grew to be six Feet high, slender, and active. "He sits a Saddle, says an Eye-witness, upright and firm, will ride 40 Miles a Day to a Fair, and deals in buying and selling Horses, which he dresses and curries as well as any Groom can do, holding the Curry-comb between his Chin and Shoulders. The same Way he holds the Goad
in

in driving the Plow, and the Spade when he digs. He throws a Stone from the Top of his Foot with greater Force than most Men can with their Hand, and seldom fails to hit his Mark. He mounts a Horse without any Assistance, and shuffling the Bridle over his Head, till he gets it on his Shoulders, guides his Horse with as little fear, and as much skill as any Man."

CHAP. II.

Of the Natural State of the Human Body.

- | | |
|---|---|
| 1. Cause of the Natural Heat, | 4. Account of Giants, |
| 2. The Blood contains much Air, | 5. Account of a remarkable Dwarf, |
| 3. Men taller in the Morning than at Night, | 6. Account of Thomas Parie and Henry Jenkins, |
| | 7. Men living without Food. |

P. 58. **W**HENCE arises the *Natural Heat* in us? This deserves a particular Enquiry.

Fermentation is that spontaneous, intestine Motion, which by the Heat of subterraneous Caverns, will in a few Hours so change Vegetable Juices (for Fermentation is confined to the vegetable Kingdom) as from a vapid Wart quenching Fire, to nourish Fire, and to afford that inflammable Liquor, commonly called Spirits.

Effervescence arises from an intestine Motion excited in various Fluids, by the Mixture of other Fluids, or of Salts or Powders of a different Nature. Acids and Alkali's when mixt, cause a great Ebullition, but no great Heat: Whereas the Solution of some Metals in Aqua-fortis, cause intense Heat, and emit Flame. Aramatic Oils mixt with acid mineral Spirits, kindle

kindle and burn with violent Explosions. And many Vegetables, putrefying with Moisture, will heat so as to kindle.

In these Cases, as there is no adventitious Fire, there must be Fire lying hid in one or other of the Bodies. And it is known much Air lies dormant in all Bodies. It is known likewise, that Fire cannot exert itself, without the Help of Air. It being granted then, that Fire and Air lie dormant in all Bodies, there is only required such an Action as may set at Liberty the Particles of Air and of Fire. By this Action the Particles of Air recover their Elasticity, and putting those of Fire in Motion, cause Heat, but not Incension, unless this Fire meet a proper Pabulum, which Pabulum is Sulphur only; tho' differently modified, whether in the Appearance of Brimstone, Oil, Spirits, Metalline Sulphur, or the most inflammable of all, Animal Sulphur, commonly called *Phosphorus*.

In *Fermentation* the Fire and Air being let loose, produce Warmth, but seldom kindle, because of the Water predominating. But in the *Efferescence* produced by the Solution of Metalline Sulphur, they kindle and sometimes cause Explosions. Aromatic Oils, containing little but the sulphureous Parts of the Vegetables, immediately kindle and break out into Flame. And Phosphorus is so highly inflammable, that if it be only exposed to the Air a few Minutes, it kindles and flames.

Now all Animals contain more or less Phosphorus. Some Insects constantly shine in the open Air. Many Sorts of Fish are luminous: Some Quadrupeds emit Light, on a very slight Friction. These are Proofs of Phosphorus lying dormant in Animal Fluids: and as they all contain Air likewise, let only the phosphoreal and aerial Particles be brought into Contact, and Heat necessarily ensues.

This clearly explains the Cause of Animal Heat: Of which the Heart and Arteries are the Occasion, not by Friction, but by the intestine Motion which the Circulation gives to the several Particles that con-

stitute the Mass of Animal Fluids. As the Velocity of these Fluids is increased, the Particles of which they consist, come oftner into Contact, and the oftner the phosphoreal and aerial meet, the more Heat they produce. And this may explain what happened to the Lady *Bandi*, and *Grace Pitt*; who having drank plenty of Gin, that Circumstance would naturally promote the kindling of the Phosphoreal Fire. And this Pabulum being largely conveyed into the most minute capillary Vessels, might produce an almost instantaneous Deflagration and Dissolution of all the solid, containing Parts.

P. 54. That much Air is wrought into the Animal Frame, appears by the following Experiments. The Blood of a Sheep fresh drawn, was in a wide mouthed Glass put into a Receiver, and the Air drawn out. After a while the subtle Parts of the Blood forced their Way thro' the clammy ones, and seemed to boil in large clusters, some as big as Nutmegs. And sometimes the Expansion was so vehement, that it boiled over the Glass.

Some Milk being put into a Vessel four or five Inches high, when the Air was drawn out, it boiled so impetuously, as to throw up several Parts out of the Glass that contained it.

And to shew, that not only the Blood, but the other Parts of Animals include Air, the Liver of an Eel was put into a Receiver: And even this apparently swelled every Way, as soon as the Air was withdrawn.

P. 58. What a Paradox is it, that all Men are taller in the Morning than in the Evening? In a young Man the Difference is near an Inch, try the Experiment as often as you please. Does not the Difference proceed from hence, that as long as the Trunk of the Body is in an erect Posture, there is a constant Pressure on the large Cartilages connecting the Vertebrae of the Spine? So long they gradually contract, and consequently a Man grows shorter. But they again

again gradually expand themselves, while we are in a reclining Posture.

There is a manifest Congruity between the Stature of Man, and his Age during the Time of his Growth. And as five Feet and an Half may be thought the ordinary Height of Man, so may seventy Years, the ordinary Period of his Years. Yet some vastly exceed in both Respects. And as we know *Thomas Parre* and *Henry Jenkins*, compleated double that usual Term of life, so we have no Reason to question, that some have doubled the common Stature of Man. *Walter Parfons*, King *James the First's* Porter, was full seven Feet, seven Inches high. Mr. *Ray* saw a Man at *Bruges*, who was eight Feet and a Half; all his Limbs well shaped, and his Strength proportionable. *Becanus* says, he saw a Youth almost Nine feet high, a Man near ten, and a Woman quite ten Feet. *Pliny* mentions several Men of the same Height in his Age. Yea *Thevet* tells us, that he met a *Spanish Merchant* on the Coast of *Africa*, who had in a Coffer the Skull and Bones of an *American Giant*, which he brought with him from that Country, who was 11 Feet, five Inches in Height, and died in the Year 1559.

From these wantantable Accounts we learn, that there have been Men 11 or 12 Feet high, which equals if not exceeds the Stature of the tallest Giant mentioned in Scripture. The Height of *Goliath* was but six Cubits and a Span, which is only nine Feet, nine Inches. Indeed the Bedstead of *Og*, the King of *Bashan*, is said to have been nine Cubits in Length. But his Bed must have been longer than his Body: We may fairly allow, nine Inches above his Head, and as much below his Feet. And making this Deduction, he was not above twelve Feet high: Much of the same Stature with the Giant whose Forehead Bone is still kept, in the Medicine-school at *London*.

In this Deviation from the common Stature of Man by Largeness, more remarkable than is com-
plete

posite? The Deviation from it by Little-ness, which has been observed in some Instances? Such was the Dwarf who lived for several Years in the Palace of the King of Poland. His Parents were healthy, strong Peasants, who affirmed, that at his Birth he weighed scarce a Pound and a Quarter, that he was presented on a Plate to be baptized; and for a long Time had a wooden Shoe for his Bed. When 18 Months old, he could speak some Words; when two Years old, he could walk almost without Help. His Shoes were then just an Inch and a Half long. When he was six Years of Age, the King of Poland gave him the Name of *Bebe*, and kept him in his Palace. His Height was then fifteen Inches, and he weighed thirteen Pounds. He was in perfect Health, his Person was agreeable and well-proportioned, but there was little Appearance of Understanding. He had no Sense of Religion, was incapable of reasoning, and could learn neither Music nor Dancing. Yet he was susceptible of Passions in an high Degree, Anger and Jealousy in particular. When 16 Years old, he was 29 Inches high, being still healthy and well-proportioned; but from that Time his Health declined; yet he grew four Inches in the four succeeding Years. At 21 he was shrunk and decrepit, and at Twenty-two it was with Difficulty he could walk an 100 Steps. In his 29d Year he fell into a Kind of Lethargy, and in a few Days died, as it were of old Age.

The two most eminent Instances of Longevity in England were *Thomas Parre* and *Henry Jenkins*. *Thomas Parre* was a poor Countryman of *Shropshire*, whence he was brought up to London by *Thomas Earl of Arundel*. At the Age of 120 he married a Widow. At 130 he could do any husbandry Work, even threshing of Corn, although soon after his Sight began to fail; nor had he the Use of his Memory, or but in a small Degree for several Years before he died. But he retained his Hearing and Apprehension.

sion to the last. He used to eat often by Day and by Night, of Milk, old Cheese with coarse Bread, Whey and small Beer. He died at the Age of an Hundred Fifty-two Years and nine Months. He might have lived much longer, but coming out of a clear thin and free Air to *London*, and from a plain country Diet, to that of a splendid Family, where he fed high, and drank the best Wines, the natural Functions were overcharged, and Death could not but soon ensue.

"*Henry Jenkins*, calling at my House, I asked, how old he was? He paused and said, "About 162, or 163." I asked, "What was the first public Transaction he remember'd?" He said, the Battle of *Flowden-Field*, being then 11 or 12 Years old."

For many Years he was a Fisherman, and used to wade in the Streams. After he was an hundred Years old, he frequently swam in the Rivers. The latter Part of his Life, he was obliged to beg. He died at *Ellerton upon Swale*, in *Yorkshire*, Dec. 8. 1670. Having lived (supposing him to have been 12 Years old, at the Battle of *Flowden-field*, which was fought Sept. the 9th, 1512) an Hundred and Sixty-nine Years, that is, sixteen longer than *Thomas Parre*.

P. 77. *John Ferguson*, of *Killmelfoord* in *Argyle-shire*, about 18 Years ago, overheated himself, drank largely of cold Water, and fell asleep. He slept for four and twenty Hours, and waked in an high Fever, ever since his Stomach loaths, and can retain no Kind of Aliment but Water. A neighbouring Gentleman to whom his Father is Tenant, locked him up for 20 Days, supplying him daily with Water, and taking Care that he should have no other Food. But it made no Difference either in his Look or Strength. He is now six and thirty Years of Age, of a fresh Complexion, and as strong as any common Man.

Gilbert Jackson, about fifteen Years of Age, in February 1716, was seized with a violent Fever, it returned

returned in April for three Weeks, and again on the tenth of June; he then lost his Speech, his Stomach, and the Use of his Limbs, and could not be persuaded either to eat or drink any Thing. May the 17th 1717, his Fever left him, but still deprived of Speech and of the Use of his Limbs, and taking no Food whatever. June 30th he was seized with a Fever again, and the next Day recovered his Speech, but without eating or drinking, or the Use of his Limbs. On the 11th of October he recovered his Health, with the Use of one of his Legs, but neither eat nor drank; only sometimes washed his Mouth with Water.

On the 18th of June 1718, the Fever returned and lasted till September. He then recovered, and continued in pretty good Health and fresh coloured, but took no Kind of Meat or Drink. On the 9th of June, 1719, he was again seized with a severe Fever. On the tenth at Night, his Father prevailed on him to take a Spoonful of Milk boiled with Oatmeal. It stuck so long in his Throat, that his Parents feared he had been choaked; but ever since that Time he has taken Food, tho' so little, that an Half-penny Loaf serves him for eight Days. All the Time he fasted, he had no Evacuation, either by Stool, or Urine: And it was fourteen Days after he began to eat, before he had any. He is now in pretty good Health.

I suppose such another Instance as this, has scarce been known in the Memory of Man.



Of the preternatural State of the Human Body.

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|---------------------------------|------------------------------------|
| 1. <i>Of the Plague:</i> | 4. <i>Of Mr. Greatrix:</i> |
| 2. <i>An involuntary Mimic:</i> | 5. <i>Way of recovering drown-</i> |
| 3. <i>An Horny Girl:</i> | <i>ed Men.</i> |

P. 84. **T**HE Plague is not an *European* Disease. It is properly a Disease of *Asia*, where it is Epidemical, and is never known elsewhere, but by Importation from thence. The Small-pox also is an exotic Disease, and was not known in *Europe*, or even *Asia Minor*, till a Spice Trade was opened by the later Princes of *Egypt* to the remotest Part of the *East Indies*. Thence it originally came, and there it rages even at this Day.

I know not whether the Gentlemen of the Faculty would not term the following, "a Disease of the *Animal Spirits*." Donald Monro, at *Strathbogie*, in *Scotland*, imitates unawares all the Motions of those he is with. He is a little, slender old Man, and was subject to this Infirmary from his Infancy. He is loath to have it observed, and therefore casts down his Eyes in the Streets, and turns them aside when in Company. We had made several Trials before he perceived it, and afterward had much ado to make him stay. He imitated not only our scratching our Head, but the wringing our Hands, and every other Motion. We needed not to persuade him to be covered; for he still covered or uncovered as we did: And all so exactly and yet with such a natural and unaffected Air, that none could suspect he did it designedly. When we held both his Hands, and
caused

caused another to make such Motions, he struggled to get free. But when we would have known more particularly, how he found himself affected, he would only give us this simple Answer, That "it vexed his Heart and his Brain."

But to what Class shall we refer the Disease of *Ann Jackson*? She was born at *Waterford*, of *English* Parents, both said to be sound and healthy, and from three Years old, had Horns growing on various Parts of her Body. She is now thirteen or fourteen; the Horns grow chiefly about the Joints, they are fastened to the Skin like Warts, and about the Roots resemble them much in Substance, but toward the End are much harder. At the End of each Finger and Toe is one, as long as the Finger or Toe itself, rising a little between the Nail and Flesh, and bending again like a Turkey's Claw. On the Joints of each Finger and Toe are smaller ones, which sometimes fall off, but others come in their Place. Round her Knees and Elbows are many; two in particular at each Elbow, which twist like Rams-horns. At each Ear grows one, yet she eats and drinks heartily, sleeps soundly, and performs all the Offices of Nature, like other healthy Persons.

P. 86. A most unaccountable Method of removing Diseases, was that of the famous Mr. *Greatrix*. "I give you nothing concerning him, says Mr. *Boyle*, but from Eye-witnesses. My own Brother some Time since was seized with a violent Pain in his Head and Back. Mr. *Greatrix* coming by Accident to our House, gave present Ease to his Head by stroking it. He then stroked his Back; The Pain immediately fled to his right Thigh. He pursued it with his Hand to the Knee, Ankle, Foot, Toe, then he stroked this, and it was gone.

My Uncle's Daughter was seized with a Pain in her Knees, which occasioned a White Swelling, she tried

tried many Remedies without Effect, for six or seven Years. Mr. *Greatrix* then coming to *Dublin*, my Aunt brought her to him. He stroaked her Knees, and the Pain fled downward from his Hands, till he drove it out of her Toes. And in a little Time the white swelling went away.

I had an Acquaintance, who after a Fever was very deaf, and had a violent Pain in her Ears. Mr. *Greatrix* put some Spittle into her Ears and rubbed them, which cured both the Pain and Deafness.

Another told me, that when a child, she was extremely troubled with the *King's-Evil*. She tried many Remedies, in vain; but Mr. G. stroaked and perfectly cured her. A Smith near us had two Daughters troubled with the same Distemper. One of these had a running Sore in the Thigh, the other in the Arm: He cured them both. He cured all Kinds of Hysteric Fits. He likewise cured the Falling Sickness, and without any Relapse, provided he could see the Patient in three or four Fits.

P. 86. A Person suffocated by the Steam of Coals, set on Fire in the Pit, fell down as dead. He lay between half an Hour and three Quarters, and was then drawn up, his Eyes, staring, his Mouth gaping, his Skin cold. Not the least Breathing being perceivable, nor the least Pulse either in his Heart or Arteries.

A Surgeon applied his Mouth to that of the Patient, and by blowing strongly, holding the Nostrils at the same Time, raised the Chest by his Breath. Immediately he felt six or seven quick Beats of the Heart: The Lungs began to play, and soon after the Pulse was felt in the Arteries. He then opened a Vein, which at first bled Drop by Drop, but in a while bled freely. Mean Time he caused him to be pulled and rubbed. In an Hour he began to come to himself; in four Hours walked Home, and in four Days returned to his Work.

Wherever the Solids are whole, and their Tones unimpaired, where the Juices are not corrupted,

where

where there is the least Remains of Animal Heat, it would be wrong not to try this Experiment. This takes in a few Diseases, and many Accidents. Among the first are many that cause sudden Deaths, as Apoplexies and Fits of various Kinds. In many of these it might be of Use to apply this Method: And in various Casualties: Such as Suffocations from the Damps of Mines and Coal-pits, the condensed Air of long-unopen'd Wells, the noxious Vapours of fermenting Liquors, received from a narrow Vent, the Steam of burning Charcoal, Arsenical Effluvia, or sulphureous mineral Acids. And perhaps those who seem to be struck dead by Lightning, or any violent Agitation of the Passions, as Joy, Fear, Anger, Surprise, might frequently be recovered by this simple Process.

The animal Machine is like a Clock: The Wheels whereof may be in ever so good Order, the Mechanism compleat in every Part, and wound up to the full Pitch; yet without some Impulse communicated to the Pendulum, the whole continues Motionless.

Thus in these Accidents, the Solids are whole and elastic, and the Juices no otherwise vitiated, than by a short Stagnation, from the Quiescence of that moving *Something*, which enables Matter in animated Bodies, to overcome the Resistence of the Medium it acts in. Inflating the Lungs, and thus communicating Motion to the Heart, like giving the first Vibration to a Pendulum, enables this *Something* to resume the Government of the Fabric, and actuate its Organs a fresh. It has been suggested, That a Pair of Bellows might be applied, better than a Man's Mouth. But 1. Bellows may not be at Hand: 2. The Lungs of one Man may safely bear as great a Force, as the Lungs of another can exert, which by the Bellows cannot always be determined: 3. The Warmth and Moisture of the Breath may likewise be of Use.



Of the Origin of Man.

Of the Generation of Bodies.

P. 97. **T**HAT some Animals first exist, not in the Seed of the Male, but wholly in the Egg of the Female, undeniably appears from the Case of Frogs and Toads: (And why may it not be the same Thing with other Animals?) The Eggs of these are not impregnated by the Male, till they issue from the Womb. It is while they are ejected, that he fecundates them with his seminal Liquor. And there is no Circumstance, by which the fecundated Egg can be known from the unfecundated. It appears therefore, that Tadpoles exist before Fecundation. For the unfecundated Eggs do not differ in the least from those that are fecundated. But these are only Tadpoles coiled up. Such therefore are the unfecundated, Tadpoles therefore exist before Fecundation; only they cannot unfold themselves without the Liquid of the Male. Frogs then should not be placed among oviparous Animals, but among viviparous: If they do not rather constitute a Class between both. Thus Nature seems to delight in diversifying the Modes of Animal Generation.

This may be the Case, with regard to one, or perhaps a few Species of Animals. But in general, where to place the pre-existent Animal or Embryo, in the *Animalcule Egg*, is still the Question. A Division of vital, essential, and original Stamina, is impossible. Yet innumerable Instances in Monsters, Mules, and many natural Subjects, concur to prove,

that

that the Young partakes of the Nature and Qualities of both the Parents, even to their Defects and Diseases, which are often hereditary. How then can we suppose unalterable Stamina? Can the visible Species of any Production, be determined by them, if every sensible Quality may be influenced indiscriminately by either Parent?

If they are placed in the Animalcule or the Egg, how are they transmitted? If in the Animalcule, why is the Process attended, with so vast an Expence; so great a Waste of Millions of Entities, each containing a Series of the most perfect and most wonderful Productions, when one only of those Millions is to take Place? And how are these Animals generated? If in the common Way, not only the Process will be boundless: These in their Seed will have others, and so on in an endless Series; but they cannot then be unalterable, because they are capable of being generated. Further, If they float in the Air, or lie hid in Food, how is it that the Stamina of one Species, do not sometimes insinuate themselves into a Parent of another Species? Or if they are excluded by proper Strainers in distant Species, they cannot be so in those that are near akin. For if the Spermatizic Animal, which in the Matrix of a Mare, produces an Horse, is yet so fitted to that of an Ass, that it can possess a Cellule there, exclusive of every other, which shews an exact Coaptitude: Certainly the same Animal, if contained in Food or Air, common to both Horse and Ass, might pass indiscriminately the Strainers of either: And so we might have Mules without the promiscuous Congress of the two Species.

In another View, if we consider the extreme Tenacity of one of these Stamina, in its first Origin at the Distance of many Ages, compared to the smallest Fibre of the Animal it is said to constitute: Can so Minute a Filament serve as a Substratum for a Cylinder, comparatively immense? Can the terraqueous Globe derive its present Dimensions, from the Dilatation of an Atom? Such is a muscular Fibre in

its present State, compared to what it was in its origin. Consequently, what must have been the Increase of extraneous Matter, either by Apposition or Incorporation, which is now as much a Part of the Fibre, as the original Stamen? And if thus much can be mechanically assimilated, why not the whole formed by mechanical Causes? Or why must so insignificant a Part of it, be supposed to be concreated with the Universe?

The Difficulty still increases immensely, if we look into the Vegetation of Plants, and the wonderful Reproduction of the Parts of the Polypus, Lobsters, and many other Animals. The original Stamina, how minute soever, unquestionless are diffused through the whole Production: Since in this System all animal and vegetable Growth is made by Developement only. But if diffused, then some or all may be lost by successive Bisection. And if lost, how can they be re-produced? If re-produced, how were they concreated with the Universe? These and a Thousand other Difficulties can in no wise be evaded, but by multiplying Supposition on Supposition, which render the Hypothesis so complex, as utterly contradicts the ordinary Process of Nature.

It is more reasonable to say, that so many secretory Ducts, so many Strainers, so many preparatory Vessels in Animals, and such a curious Disposition in Plants, for the Continuation of every Species, imply a Digestion, Secretion, and Preparation of Principles, invariably productive of every Individual, when they fall into their respective Matrixes, and find Aliment proper to assimilate? Are not these Principles contained in the Nourishment taken by the Parent Plant or Animal, the same that continually vegetate in it, and increase it till it is adult, then exuberate, while it is by new Preparations fitted, invariably to propagate its Kind? Else why this Digestion? Why this Secretion? Why so many Strainers, Receivers, Ducts and Valves? And why is some Food more productive of these Principles than others?

And

And if every mixt Body is made up by the Combination of certain Principles, we cannot doubt, but God may have established Forces in Nature, by which such Principles may in certain Circumstances, be invariably united, without any Danger of deviating, so as to render Generation equivocal. And if every Production in Question is a mixt Body, we know that how various so ever they are, a small Number of Principles differently combined, will yield Variety enough to produce them all. Thus we reduce Nature to what it is ever found to be, simple in the Beginning of its Course, but afterwards, when it is distributed, magnificent beyond Expression.

Modern Naturalists all agree, That every Plant proceeds from its specific Seed, every Animal from an Egg, or something analogous, pre-existing in its Parent. But what do we mean by Seeds and Eggs? These in the common Sense of the Words, are certain mixt Bodies, that immediately furnish those Productions. They are said to contain not only the pre-existent Germ, but the fit Nidus also, and Aliment to be assimilated in proper Circumstances. They are therefore heterogeneous Bodies, that coalesce in a known Time. And their Principles are so far from being united at the Creation, that they sensibly come together from distant Places in all hermaphrodite Plants, and from different Individuals in all those Species, where the Male and Female are distinct.

But it is vain for us to lay down any certain Rule, and to say to Nature, "This is thy Scheme, from this thou shalt not deviate." If she makes it a Law in many Species, that every Individual requires the Co-operation of a Male and Female Parent: She has at the same Time her Hermaphrodites, both in Plants and Animals. And if in some Hermaphrodites, the Sexes are so distinct, that she seems not to deviate far from her primitive Law: She will, in another Instance, that of the Pucerons, act either with or without the Co-operation of a Male. Again: In some Species the Female may be so impregnated, that the

Impreg-

Impregnation shall diffuse itself to five or six Generations. Yet again: In many Kinds of Polype, Generation proceeds, without Male or Female, Egg or Seed. And farther still; there are some Species of Polypes, where a whole Family, (after branching out by real Vegetation, as far as Nature designs) jointly contants to furnish one Egg, as the Source of a future Progeny. If at last you resolve to stand by this, that at least every individual proceeds from a Parent like itself: Even this is overthrown by late Experiments. For we have now a Cloud of Instances, of a Class of Beings hitherto unknown, wherein Animals grow upon, are produced by, and in the strict Sense of the Word, brought forth from Plants. Then by a strange Vicissitude they become Plants of another Kind. These again become Animals of another, and thus on for a Series farther than the utmost Power of Glasses can carry the most inquisitive Observer.





Part the Second.

CHAP

Of Beasts.



1. *Of the Rhinoceros,*
2. *Of the Llama,*
3. *Of the Beaver,*

4. *Of Sable, &c.*
5. *Variety in the Shape and Colour of Beasts.*

P. 108 **T**HE outer Skin of the *Rhinoceros*, which consists of many Folds, is thick and impenetrable. In running one's Finger under one of the Folds, it feels like a Piece of Board half an Inch thick. But between the Folds the Skin is as smooth and soft as Silk, and easily penetrated. See here the Wisdom of the great Creator! If the outer Skin, which is quite inflexible, was continued all over him without any Fold, he could not perform any Action whatever. But the Suppleness of Skin in other Beasts, is compensated in this by these Folds. It was necessary his Skin should be hard for his Defence: Meantime it was a noble Contrivance, that it should be so soft and smooth underneath, that when he bends himself any Way, one Part of this board-like Skin, should slide over the other. And these Folds are placed in such Parts of his Body, as to facilitate the Performance of every voluntary Motion.

P. 109.

P. 109. The *Lama's* in *Peru*, have small Heads, resembling in some Measure both an Horse and a Sheep. The upper Lip is cleft, like that of an Hare, through which, when they are enraged, they spit, even to ten Paces Distance, a Sort of Juice, which when it falls upon the Skin, causes a red Spot and great itching. The Neck is long, like that of a Camel, the Body like that of a Sheep, but with much longer Legs. It yields strong and fine Wool, and is also a Beast of Burden, and kept at an easy Expence. It carries its Burden a vast Way, without tiring, eats very little and never drinks. At Night he lies down, and no Blows can make him rise, or move one Foot till Morning.

P. 111. The Feet of the Female *Beaver*, which a Gentleman kept in *England* some Years since, were webbed, like those of a Goose. The Tail was scaly, and shaped like the Blade of an Oar. This she used as a Rudder to steer herself, especially when she swam under Water, which she would do for two or three Minutes, and then come up to take Breath, sometimes raising only her Nostrils above Water. She swam swifter than any Water-fowl; and under Water as swift as a Carp. The hind Legs being longer than the Fore, made her walk slow on dry Land, or rather waddle like a Duck. If drove along fast, she could not run, but went by Jumps, flapping her Tail against the Ground. She never made any Noise, except a little Sort of a Grunting, when angry, or driven fast. As the Beaver frequents the Water like Water-fowls, may not the Castor be provided for him by Nature, to anoint his Fur with, and prevent the Water from soaking to his Skin. And as it is impregnated with penetrating, pungent Particles, it may likewise contribute to keep off the Chill, which the Water might otherwise strike to his Body, when he remains long therein.

P. 112. The *Sable-mice*, (which were first observed in *Lapland*, in 1697,) are near as big as a small Squirrel.

rel. Their Skin is streaked and spotted black and light brown. They have two Teeth above and two under, very sharp and pointed. Their Feet are like a Squirrel's. They are so fierce, that if a Stick be held out to them, they will bite it, and hold so fast, that they may be swung about in the Air. In their March they keep a direct Line, generally from North-East to South-West. Innumerable Thousands are in each Troop, which is usually a Square. They lie still by Day, and march by Night. The Distance of the Lines they go in, parallel to each other, is of some Ells. Whatever they meet in their Way, tho' it were a Fire, a deep Well, a Torrent, Lake, or Morass, they avoid it not, but rush forward. By this Means many Thousands of them are destroyed. If they are met swimming over a Lake, and are forced out of their Course, they quickly return into it again. If they are met in Woods or Fields and stop, they raise themselves on their hinder Legs, like a Dog, and make a Kind of barking Noise, leaping up as high as a Man's Knees, and defending their Line as long as they can. If at last they are forced out of it, they creep into Holes, and set up a Cry, sounding like *Biab, biab*. If a House stand in their Way, they never come into it, but stop there till they die. But they will eat their Way through a Stack of Corn or Hay. When they march through a Meadow, they eat the Roots of the Grass; And if they encamp there by Day, they utterly spoil it, and make it look just as if it had been burnt. They are exceeding fruitful: But their Breeding does not hinder their March. For some of them have been observed, to carry one young in their Mouth, and another upon their Back. In Winter they live under the Snow, having their Breathing-holes, as Hares and other Creatures have.

V. I. 120. The Variety of Shape and Colour observable in *Beasts*, prevents any two from being exactly alike, as much as the human Features distinguish Mankind one from another. Wherefore then was

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this

this Variety bestowed upon Brutes? Are they at all sensible of such Diversity? Are they the more happy, or more useful to one another for it? No. This Variety then is doubtless intended for the Sake of Man, to prevent Confusion, and decide and ascertain his Property.

CHAP. II.

Of Birds.

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|------------------------------------|----------------------------------|
| 1. <i>Of the Art of Flying,</i> | 4. <i>Of the Solan Goose,</i> |
| 2. <i>Of the Virginian Martin,</i> | 5. <i>Of the Eagles in Rona,</i> |
| 3. <i>Of Birds of Passage,</i> | 6. <i>Of Barnacles.</i> |

P. 125. **T**HE *Art of Flying* has been seriously attempted by many, in various Ages, particularly in the Time of our famous Friar Bacon, who lived about 500 Years since, and whom his excellent Works shew to have been a rare Chymist, an excellent Mathematician, a knowing Mechanic, and a most accomplished experimental Philosopher. Yet even he believed, the Art of Flying possible, and says, he himself knew how to make an Engine, in which a Man sitting might be able to convey himself through the Air, like a Bird. Nay he affirms, That there was then another Person, who had actually tried it with Success.

VI. p. 141. I know not how we can doubt of the Fact, that Swallows have been found in Winter, under Water, clung together, attested by Men of unquestionable Veracity. And yet others affirm, that they have seen Flights of Swallows crossing the Sea in Autumn. The Truth seems to be this. There are

some

some Species of Swallows, which seek a warmer Climate at the Approach of Winter, while others remain here, in a temporary Death, like the Flies on which they feed.

They have in *Virginia*, a *Martin* like ours, only larger, which builds in the same Manner. Col. *Bacon* observed for several Years, that they constantly came thither upon the Tenth of March. Two of them always appeared a Day or two before, hovering in the Air. Then they went away, and speedily returned, with the whole Flock.

The following seems to be a very rational Account of those which are really Birds of Passage.

V. I. p. 141. When by the Approach of our Winter their Food fails, *Birds of Passage* are taught by Instinct to seek it elsewhere. Want of Food seems to be the chief, if not the only Reason of their Migration. The Length of their Wings enables them to catch the Flying Insects, with which the Air is stored during the warm Months. And most *Summer Birds of Passage*, feed on the Wing upon such Insects as are seen no more when Winter comes. If it be considered, how much of the Globe still remains unknown, it is no Wonder, we are not yet acquainted with the Places to which they retire. Probably they lie in the same Latitude in the Southern Hemisphere, as those from whence they depart.

As *Swallows* cannot bear so much cold, as some other Birds of Passage, they are constrained to visit us somewhat later, and to depart sooner. Some stay a Month after them. Probably many of them perform their long Journeys chiefly in the Night. Lying on the Deck of a Sloop on the North Side of *Cuba*, I and the Company with me, heard three Nights successively, Flights of *Rice-birds* (their Notes being plainly distinguishable) passing over our Heads Northerly, which is their direct Way from the Southern Continent of *America*, from whence they go yearly when

the Rice begins to ripen, and after growing fat, return back.

There are also *Winter Birds of Passage*, which arrive here in Autumn and go away in Spring, namely, the Fieldfare, Redwing, Woodcock and Snipe. But the two latter sometimes spend the whole Year here: Whereas the two former constantly at the Approach of Summer, retire to more Northern Climates, where they breed, and remain till at the Return of Winter, they return to us again.

The Winter Food of these Birds being Berries and Haws, which are far more plentiful here than in more Northern Regions, these are one Reason of their coming over: But the Principal is, the Severity of the Weather in those Climates, which Nature teaches them to exchange, for such as are more temperate. But why do they depart from us in Spring? This still remains among the Secrets of Nature.

Beside these Summer and Winter Birds, there are others which come periodically to certain Places, for the Sake of some Sort of Food, which their own Country is destitute of. These quickly depart, and are seen no more till that Time Twelvemonth. Such are the Rice-bird and Blue-wing of *Carolina*.

But above half a Century passed, from the Time of cultivating Rice and Wheat in *Carolina* and *Virginia*, before these foreign Birds made their Appearance there. The *Wheat* Birds now come annually to *Virginia*, when the Wheat ripens, and have come every Year, since their first appearance, in numerous Flights.

P. 144. After same Nest.

The *Solan-Goose*, somewhat less than a Land Goose, is white: Only the Tips of its wings are black, and the Top of the Head yellow. The Bill is long, and so sharp-pointed, that it pierces an Inch deep into a Board, when they stoop at fish which are laid there on. This is one Way of catching them. When they

they sleep, they put their Head under their Wings: But one keeps Watch. If that be surprized by the Fowler, which frequently happens, all the rest are easily caught by the Neck, one after another. But if the Centinel cries and gives them warning, the whole Flock escapes. When they fish for Herrings, which come in Shoals, they fly near sixty Yards high, and stoop perpendicularly: But when they aim at a single Fish, they descend assant.

There is always one Tribe among them which is barren: These keep together, and never mix with them that build and hatch. (Is it not probable, that these are the Males, like the Drones among the Bees?) The Solan Geese come to the Western Isles in Scotland, in March taking the Advantage of a South-west Wind. They send a few before them, who make a Tour round the Isles, and then return to their Company. In a few Days after, the whole Flock comes together, and stays till September. All this Time they are daily making up their Nests, in the Shelves of high Rocks. They fish, hatch and make their Nests by Turns. In order to this they amass together, not only Heaps of Grass, but whatever else they find floating on the Water. In a Nest on St. Kilda, was found a Soldier's red Coat, and some *Molucca* Beans in another.

They are thought the sharpest sighted of all Sea-fowls. They have a large Gorget, somewhat like a Pelican, in which one of them will preserve five or six Herrings intire, and carry them to her Nest, where they empty them out, for Food to their Young. Nay, they have been observed to go a Fishing, to some Isles which are thirty Leagues distant, and bring the Fish in their Gorget all that Way.

P. 146. After with others.

In the Isle of *Rona*, (one of the Scotch Western Isles) there are a Couple of Eagles, which the Natives say, not only drive away their Young as soon as they are able

able to fly, but keep Possession of the Island, not suffering any of their Kind to live there but themselves.

There are also a Couple of *Ravens* in this Island, which beat away all ravenous Fowls. And when their own Young are able to fly, they beat away them likewise.

But who can account for another Matter of Fact, which is continually observed on the *Western Islands*? The Western Ocean throws up on their Shores, great Quantities of weather-beaten Timber, on which hang Multitudes of little Shells, fastened to one another, much as *Muscle-shells* are. In every one of these Shells is a perfect Fowl: The little Bill is like that of a Goose; the Eye marked; the Head, Neck, Breast, Wings, Tail and Feet formed. The Feathers are perfectly shaped, and of a blackish Colour, and the Feet like those of other Water-fowl. But we cannot hear of any Person, that ever saw any of them alive.

Now, as Bats are a Kind of Medium between Beasts and Birds, are not *Barnacles* a Kind of Medium between Birds and Fishes?

CHAP. III.

Of Fishes.

- | | |
|----------------------------------|-----------------------------------|
| 1. <i>Experiments on Fishes:</i> | 8. <i>Of the King of the Her-</i> |
| 2. <i>Of Crabs Eyes:</i> | <i>rings:</i> |
| 3. <i>Of Oysters:</i> | 9. <i>Of Salmon-leaps:</i> |
| 4. <i>Of the Murex:</i> | 10. <i>Of Sharks:</i> |
| 5. <i>Of Pearl-Muscles:</i> | 11. <i>Of Whales:</i> |
| 6. <i>Of other Muscles:</i> | 12. <i>Of Tortoises:</i> |
| 7. <i>Of Fish in Stones:</i> | 13. <i>Are all Fishes Mute?</i> |

P. 156. **T**HERE is something extremely odd, in the Experiments of an ingenious Man,

on some of our common *Fishes*. "I put a Banstickle, says he, in a Glass Jar filled with Water: At first, it refused to eat any Thing, which is common with all Fishes, but afterwards it grew so tame, as to take small Worms out of my Hand. Nay, it was so bold at last, that when its Belly was full, it would set up its Prickles, and with all its Strength, make a stroke at my Fingers, if I put them near it.

"This Fish was so unsociable, that it would suffer no other Fish to live in the Jar with it, and so audacious as to attack whatever I put in, tho' ten Times its own Size. One Day I put in a small Ruff, the Banstickle instantly assaulted it, tore off Part of its Tail, and I am persuaded would have killed it, had I not separated them.

"The Abilities they use to get from Place to Place, are likewise extraordinary. Tho' they are scarce two Inches long, I have seen them leap out of the Water a Foot high perpendicularly, and much farther obliquely, when they wanted to get over some Obstacle in their Way.

"Nature has furnished them with a kind of Breastplate, to be a Defence against outward Injury, and with Prickles upon their Sides and Back, which they erect on the least Appearance of Danger.

"I have always observed among the Fish I keep in Jars, that such as I keep awhile together, contract so great an Affection for each other, that if they are separated, they grow melancholy and sullen. About Christmas I put two Ruffs into a Jar, where they lived together till April. I then gave one of them to a Friend, the other was so affected, that for three Weeks it would eat nothing. Fearing it would pine to Death, I sent it to its Companion: being put to this, it ate immediately, and presently recovered its former Briskness.

In the Beginning of September, says the same Gentleman, I procured a small *Dace*, which I kept in a Glass Jar, till the latter End of May following.

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All this while it ate nothing except the small Animalcule, which happened to be in the Water I gave it, once a Day in Winter, and twice or thrice in the Spring, as the Weather grew warmer. When the Water was fresh, it came up to the Top about once an Hour, to blow out some small Bubbles of Air. Then putting its Nose near the Surface, it took in fresh, and retired to the Bottom again. But as the Water became less pure by its Use, its returns to the Surface were more frequent, and at last it would remain there continually, till I gave it a fresh Quantity. I believe I might have kept it for Years, but Business one Day prevented me from giving it clean Water in due Time, which put a Period to the Life of my little Companion.

At first it would not suffer me to come nigh the Glass, without the utmost Confusion and Surprize, but at last it grew so tame, that I if came but in Sight, it would be sure to be at the same Side of the Glass, and lie gazing at me, until I was weary of observing it. I often took the Opportunity of looking at it by Candle-light, which it seemed to take great Pleasure in.

In the above mentioned Month, I put into another Glass, a Ruff about three Inches long. At first he too appeared mighty reserved, and would not eat, nor suffer me to come nigh him, but in a short Time all-powerful Hunger tamed him, for he could not, like the Dace, live on the small Inhabitants of the Water, and so was quickly forced to take whatever I provided for him. In a while it grew so tame, that it would not only eat small Worms which I threw into the Glass, but would take them out of my Hands. Nay, it would even rise out above the Water for them; which is contrary to the Way wherein this Kind of Fish uses to take its Food. At last, it would come to my Hand, whenever I put it into the Glass, and suffer me to handle it. When I had

I had made all the Observations I thought proper after eight Months I gave him his Liberty.

Crabs-Eyes so called, are found in the Bodies of *Cray fish*. Each Fish produces two yearly, one on each side of the Stomach, between the Coats of it. Here it grows Coat upon Coat, and is supplied with petrifying Juices by Vessels opening on the inner Surface of the outward Coat. The first Scale, whereon all the others are formed, may be perceived in the Center, the Brims or Circumferences of many of the rest being likewise apparent. It is believed, that they cast these Stones with their Shells yearly; but this is not the Case. For about the Time of casting their Shell, the Stones break thro' the internal Coat of the Stomach, and being ground by the three serrated Teeth therein, become dissolved in the Space of a few Days, which makes it difficult to find them just at this Time.

They eat the old Shells immediately after shedding them. Perhaps these Stones may be designed to furnish new petrescent Juices to its Fluids, for the Reproduction of their annual Dress.

It may be worth observing, that *Lobsters* use their Tails as Fins, wherewith they commonly swim backward, by Jirks or Springs, reaching sometimes ten Yards at a Spring. For this Purpose, as the *Gill-fins* of other Fishes, which are their Oars, are a little concave backward, these have the Plates of their Tails, when they bend them down as they use to do, a little concave forward.

Oysters spawn on the *Irish* Coasts in the Summer months. Their Spawn sticks to Stones, Oyster-shells, or any such Substance at the Bottom of the Sea. They are near two Years before they come to full Growth, they move very little from the Place where they first lie.

Among

Among the *Shell-fish* on the *Waterford Coast*, is the *Murex*, which gave the *Tyrian Purple*. It is in great Plenty there, and is by the *English* called an *Horse-winkle*. The *Shell* is about an Inch long, and half an Inch broad, and turns spirally like a *Snail-shell*. Each *Fish* has a peculiar *Reservoir*, which contains a large Drop of *Liquor*, if this is prest out on *Linen*, the *Linen* first appears of a dirty *Yellow*, inclining to *Green*, afterward it changes to a *Lemon Colour*, then to a deep *Green*; then it turns to a deep *Blue*, and at last to a charming *Purple*.

The *Shells* of the antient *Purple-fish*, are still common upon the *Tyrian-shore*. The *Fish* itself is found in great Abundance in the Seas of the *Spanish West-Indies*, near *Panama* and *Nicoya*, exactly agreeing with *Pliny's* Account of the antient *Murex*. *Cloth of Segovia* died with this *Purple*, which is sold for 20 *Crowns* an *Ell*, and is very rarely worn by any, but the greatest *Noblemen* in *Spain*. The *Caribbee Islands* have also the same Sort of *Fish*, which we may likewise find nearer home, namely on the *Coasts of Somersetshire*, as well as of *South Wales*.

The *Pearl Muscles* lie partly open: The inside of the *Shell* is of a pearly Colour. The *Pearl* lies in the smaller End of it, at the Extremity of the *Gut*, and out of the *Body* of the *Fish*, between the two *Films* that line the *Shell*. This answers to the *Stone* in other *Animals*, increasing by *Crusts* growing over one another. Accordingly if a *Pearl* be pinched in a *Vice*, the upper *Coat* will crack and leap away. And as it is now known, that the *Shells* of *Fishes* are formed of stony Matter oozing out of their *Body*, it is no Wonder if that Matter when it chanches to overflow, bursts forth in any *Cavity* of the *Body*, and forms a little *Mass*, which hardening becomes a *Pearl* of the same Colour with the *Shell*.

Whereas all other *Animals* take in *Nutriments* by the *Mouth*, the *Muscle* takes it in by the *Anus*. The Part called the *Head*, tho' without *Eyes*, *Ears* or *Tongue*,

Tongue, is immovably fastened to one of the Shells; so that it cannot receive any Thing. The Food of a Muscle is Water, which as the Shell opens, enters in at the Anus, and passing on by certain Canals running between the Shell and the Animal, is thence conveyed into the Mouth.

What is farther surprizing is, that it is an Hermaphrodite; but one of a peculiar Kind, for it propagates (not as Worms and Snails, reciprocally) but independent of any other Animal. So that itself is both the Father and the Mother of its own Offspring.

We have lately discovered a progressive Motion in those Shell-fish, which were supposed to be quite fixt. Even Oysters, which one would think wholly immovable, if they are thrown irregularly into a Vessel of Water, will in a while turn themselves, till the smooth Shell becomes uppermost: Otherwise they could hold no Water in the concave Shell for their Sustenance.

Muscles can walk on the Ground, which they do on this Manner. Lying on the flat Side of their Shell, they thrust out a Part, in Form of a Tongue, wherewith they make little Motions to the Right and Left, and thereby dig a Passage in the Sand. In this digging they drop gradually on one Side, and so get the Shell mounted on its Edge, then they stretch out the Tongue as far as they can, and rest for a Minute or two on its Extremity, to draw the Shell after them as Water-snails do. This Motion is repeated as long as they please; thus they form a Sort of Groove in the Sand, which sustains the Shell on either Side, and leaves behind them a Sort of irregular Tract, three or four Yards long. In Rivers abounding with Muscles one may see many of them, with a Muscle at the End of each.

That called the *Arm* or *Leg* in a *Sea-Muscle*, which in its natural State is not above two Lines long, may reach out of the Shell two Inches: And the Muscle having laid hold on a fixt Point therewith, bends
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and shortens it, and so drags itself on. The *Beard* serves for an Anchor to fasten it to some heavy Body, that it may not be carried away with the Motion of the Waves.

When a *Pond-Muscle* walks, it thrusts out its whole Belly, in form of the Keil of a Ship, and creeps on its Belly as the Serpent does. So true it is, that Nature is not confined in her Manner of Operation, but is ever varying, tho' never confused.

P. 157. In *Port-Mahon* Harbour, there are Stones from Half an Hundred to five Hundred Weight each, lying at all Depths, full of Shells, each containing a single Fish, of the *Muscle* Kind. The Holes in the Surface are far narrower than the Hole in which is the Fish, which it seems is capable of enlarging its Room, as it grows bigger by abrading the Sides of its Cells. And this is apparent, from the sandy Matter found in the Bottom of those Cells, whenever the Orifice is higher than the Bottom; for then the Fish cannot throw it out.

The *Bollani* likewise in the *Adriatic* Sea, live in large Stones. Their Shell is rough and oblong, not unlike a Date. They are found in several Kinds of porous Stones. In the Pores of these the Spawn is deposited. Frequently the Aperture thro' which it was injected, is no longer perceivable; but the Fish thrives notwithstanding. On breaking some of these Stones, one finds near thirty live Fish, tho' no Opening can be perceived on the Outside. Each has just Room to open its Shell, the Inside of which is white, the Outside Ash-colour; the largest is four or five Inches long. Both the Fish itself and its Juices are so luminous, one may see to read by it, and even Water in which it has been squeezed, put into a Glass, will shine ten or twelve Hours.

Likewise in *Toulon* Harbour are found solid Stones containing in separate Cells, secluded from all Communication with the Air, several living Shell-fish. The same are found along the Coast of *Ancona*, in
Stones

Stones weighing 50 Pounds and upwards. The Outside of which is soft, but the Inside so hard, as to require an Iron Mall, and a strong Arm to break them:

It is plain therefore that Life may subsist even without *Air*: As appears likewise undeniably from two Memoirs given by the Academy of Sciences at *Paris*. "In the Center of a large Elm, four Feet above the Root, was found a Toad, filling up the whole vacant Space. No sooner was the Wood split, than it crept away in haste. No Tree could be more sound. Then how came it there? Probably the Egg whence it was formed, was lodged in the Tree at its first Growth, by some singular Accident. There it lived, tho' without Air, feeding on the Juices of the Tree, and growing as the Tree grew. Since then we have been certainly informed of one found in an Oak larger than that Elm. By the Time requisite for the Growth of the Tree, it must have subsisted there, without any Commerce with the external Air, for eighty or an hundred Years."

A like Fact is related by *Ambrose Pare*, chief Surgeon to *Henry II* of France. "Overlooking my Labourers, whom I had set to break some hard and large Stones, in the Middle of one, we found an huge Toad, full of Life, tho' there was no Aperture in the Stone: And the Labourer told me, it was not the first Time he had found such, in huge Blocks of Stone, which had no visible Opening.

Other Authors of undoubted Credit, give us Accounts of Frogs, Snakes, Crabs and Lobsters, found alive within large Stones and Blocks of Marble. Without attempting to account for these Facts, we may infer from them,

1. That the Eggs from which these Creatures proceeded, were lodged in the Tree at its first Growth, or in the soft Mud, out of which the Stones were formed:

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2. That

2. That they have subsisted there 50, an 100, an 150 Years, or more:

3. That consequently they have lived far longer than Animals of the same Kind do, when at Liberty:

4. That all the Time they had no Aliment but the Sap of the Tree, or Moisture penetrating the Stone:

5. That they lived without any more Air, than was contained in those scanty Cells:

6. That to this Exclusion of the external Air, their Longevity was chiefly owing: And

7. That either they were provided at first with Cells proportioned to their utmost Size, or as they grew, they had the Sagacity to enlarge their Cells, by repelling or gradually abrading the Sides that formed them.

But what a Life was this! Here was *gentle inactivity* for a Century together!

P. 161. The Fishers on the Western Isles of *Scotland* observe, That there is a large *Herring*, double the Size of a common one, which leads all that are in a Bay, the Shoal following him wherever he goes. This Leader they term, *The King of Herrings*: And when they chance to ketch it alive, they drop it carefully into the Sea, judging it petty Treason to destroy a Fish of that Name.

P. 163. At *Leixlip*, seven Miles from *Dublin*, there is a fine Water-fall, or *Salmon-leap* so called, from the numberless Salmon which leap up it, at the Season of the Year for spawning. When they come to the Foot of the Fall, you may observe them frequently to leap up just above the Water, as if to make an Observation of the Distance. Soon after they leap up again, with an Attempt to gain the Top, and perhaps rise near it; but the falling Water drives them down again. The same Fish soon springs up again, and rises above the Fall; yet this is equally unsuccessful, for dropping with their Broadfides on the

the rapid Curvature of the Waters, they are thrown back again headlong. The only Method of succeeding in their Attempt, is to dart their Heads into the Water, in its first Curvature over the Rocks. By this Means they first make a Lodgment on the Top of the Rock for a few Moments, and then scud up the Stream. There seems to be a peculiar Instinct in them, to aim at this very Point; for the Force of the Stream on the Top of the Precipice, is less at the Bottom, close to the Rock than on the Surface. 'Tis almost incredible, the Height to which they will leap, they frequently leap near twenty Feet. The Manner of their doing it is, by bending their Tails round, almost to their Heads; it is then by the strong re-action of their Tails against the Water, that they spring so much above it.

P. 163. The *Shark*, as vast as his Strength is, has no Bones, except in his Head. His Jaws are only Gristles, and he has three, four, five, or perhaps more Rows of Teeth, as he grows in Years. These are just like Lancets, and are moveable, erected or lying flat, as he pleases. His Ribs are all Gristles; so is his Spine, yet divided into Vertebrae. The *Shark*, the *Dolphin*, and the *Spanish Mackrel* swim faster than any Ship sails.

P. 164. The *Whalebone Whale* is about 70 Feet long, and very bulky, having Scales, and no Fins, but only one on each Side, from five to eight Feet long.

The *Spermaceti Whale* is much of the same Dimensions. The *Spermaceti Oil* lies in a great Trunk, four or five Feet deep, and ten or 12 Feet long, near the whole Length, Breadth and Depth of the Head. It seems to be no other than the Brain. Not but some other Parts of the Fish yield an Oil; but not so good as that in the Trunk.

The Care of their Young is remarkable: While they carry them under Water, they often rise for the Benefit of the Air. However they are chased or wounded

wounded, as long as they have Sense, and perceive Life in their Young, they will not leave them, and if in their flying, the young one drops off, the Dam, comes about, and passing underneath takes it again.

Whales are gregarious, being sometimes found an Hundred in a swell, and are great Travellers. In Autump the Whalebone Whales go Westward; in Spring Eastward again. The several Kinds of Whales do not mix with each other, but each keep by themselves.

Their wonderful Strength lies chiefly in the Tail. A Boat has been cut down from the Top to the Bottom by the Tail of a Whale, and the Clap-boards hardly splintered, tho' the Gunnel on the Top was of tough Wood. Another has had the Stern-post, three Inches thick, cut off smooth without so much as shattering the Boat, or drawing the Nails of the Boards.

P. 168. There is something highly remarkable in the Change of Tadpoles into Frogs: But there is something still more remarkable in the *Frog-fish*. These are found in great Numbers in the River of *Surinam*. At first they are perfect Frogs, they are spotted with brown, yellow and green; but are paler on the Belly, their hinder Feet are webbed, like those of a Goose, the Fore-feet without Webs. The first Change the Animal undergoes, is by the growing of a Tail. After this the Fore-feet decrease, and perish by Degrees. The Decrease of the hinder Legs follows, and at last the Frog is changed into a perfect Fish.

P. 169. The *Blood of Tortoises* is colder than any common Spring Water: Yet is the beating of the Heart as vigorous as that of any Animal, and the Arteries as firm as those of any Creature.

It has been commonly supposed, that all Fishes are mute, as well as void of Hearing. But a late Author says, There is one Kind of Whale, that when they

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are struck roar so loud as to be heard two Miles. He likewise asserts, that some of them have Hearing, as have Frogs, Snakes and all the Lizard Kind, tho' they have not the usual outward Apparatus of Hearing. But they have the Auditory Passage, by which Sound is conveyed, and internal Organs, to which the Meatus Auditories reaches. This is observable in all the Whale-kind, and in all Fishes that have Lungs. And whereas some have supposed, that Water cannot transmit Sound, the contrary of this is now well known. Many Experiments have shewn, that even a Man under Water may hear what is spoken in the open Air.

CHAP IV.

Of Reptiles.

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| 1. <i>Serpents may be drowned :</i> | <i>their Skin :</i> |
| 2. <i>Of the Venom of a Viper :</i> | 8. <i>Reproduce Parts cut off :</i> |
| 3. <i>Of Rattle-snakes :</i> | 9. <i>So do Worms :</i> |
| 4. <i>The Effects of their Poison :</i> | 10. <i>And Snails :</i> |
| 5. <i>Of Lizards :</i> | 11. <i>Of Tape-Worms :</i> |
| 6. <i>Of Chameleons :</i> | 12. <i>Of Microscopic Worms.</i> |
| 7. <i>Water-lizards often change</i> | |

P. 172. **S**ERPENTS will swim a long Time, but they cannot stay long under Water, without being suffocated. In Winter they retire under Stones, Roots of Trees, old Walls, or any warm, dry Shelter. Here they sleep half dead, tho' with their Eyes open, till the returning Sun recalls them to Life.

P. 173. The Venom of a Viper is not mortal to a sound and robust Body, though attended with painful Swellings, violent Vomitings, Phrenies and Convulsions. In eight or ten Days, the Poison having run thro' divers Parts of the Body, throws itself into the Scrotum, and swelling it extremely, causes great Heat, and much Urine very hot and sharp, by which it is discharged, this being the certain Crisis of the Disease.

But a sickly or fearful Person, bit by a Viper surely dies, if there be not speedy Help. Any one bit, in two or three Days weighs almost as much more as he did before. Who can account for this?

It is remarkable, that the youngest Vipers are provided with poisonous Teeth grown to Perfection, commensurate to their Bulk; that so they may be able to kill their Prey and feed themselves, as soon as they are born.

P. 174. A common Snake will avoid a Man; but a *Rattle-snake* never turns out of the Way. His Eye has something so terrible in it, that there is no looking stedfastly at him. But he creeps very slow, with his Head close to the Ground, so that one may easily get out of his Way. His leaping is no more than uncoiling himself, so that a Man is in no Danger, if he is not within the Length of the Snake. Neither can he do any Harm, unless he first coil, and then uncoil himself; but both these are done in a Moment.

The Noise they make is not owing (as some imagine) to little Bones lodged in their Tails. But their Tail is composed of Joints that lap over one another, like a Lobsters, and they make that Noise by striking them one upon another. This is loudest in fair Weather; in rainy Weather they make no Noise at all. It is remarkable, that whenever a single Snake rattles, all that are within hearing rattle in like Manner.

Of how extremely penetrating a Nature is their Poison? A Man provoking one of them to bite the

Edge

Edge of his Broad-axe, the Colour of the steeled Part presently changed: And at the first Stroke he made with it in his Work, the discoloured Part broke out, leaving a Gap in the Axe.

A Gentleman has lately given a particular Account, of what he felt after being bit by one of them.

"Hearing, says he, a Bell upon the Top of a steep Hill, which I knew to be on one of the Cows of the People where I then quartered, I went right up the Hill; but near the Top my Foot slipped and brought me down upon my Knees. I laid my Hand on a broad Stone to stay myself; I suppose the Snake lay on the other Side, who bit my Hand in an Instant, then slid under the Stone, and sounded his Rattles. But I soon found him, crushed his Head to Pieces with a Stone, took him up in my left Hand, and ran Home, sucking the Wound on my Right hand, and spitting out the Poison. This kept it easy; but my Tongue and my Lips grew stiff and numb, as if they were froze. When I came Home, one presently ripped a Fowl open, and bound it upon my Hand. This eased me a little. I kept my Elbow bent and my Fingers up, which kept the Poison from my Arm. Another bruised some Turmeric, and bound it round my Arm, to keep the Poison in my Hand. This kept my Arm easy for some Hours, and my Hand tho' numb, was not much swelled, nor even painful; but about Midnight it puffed up on a sudden and grew furious, till I slit my Fingers with a Razor. I also slit the Back of my Hand and cupped it, and drew out a Quart of slimy Stuff, yet my Arm swelled. Then I got it tied so fast, that it was almost void of Feeling. Yet would it work, writhe, jump, and twine like a Snake, change Colours and be spotted. And the Spots moved to and fro upon the Arm, which grew painful at the Bone. All Things were applied for two Days which could be thought on; but without Effect, till the Ashes of White Ash-bark made

made into a Plaister with Vinegar, drew out the Poison. We then untied my Arm; but within two Hours all my Right-side turned black. Yet it did not swell, nor pain me. I bled at the Mouth soon after, and continued bleeding and feverish four Days. The Pain raged still in my Arm; and I was by Times, desirous for an Hour or two. After nine Days the Fever went; but my Hand and Arm were spotted like a Snake all the Summer. In Autumn my Arm swelled, gathered and burst, so away went Poison, Spots and all.

But the most surprizing Circumstance was my Dreams. In all Sickneses before, these were always pleasant. But now all were horrid. Often I was rolling among old Logs; sometimes I was a white Oak cut in Pieces. Frequently my Feet would be growing into two Hickary Trees: So that it was a Terror to me, to think of going to sleep.

P. 177. The Eyes of a *Chameleon* are of the Size of a Pea, which it moves in a wonderful Manner, the one backward, the other forward, the one upward, the other downward, or if it fixes one Eye on an Object, while the other moves according to the Motion of another Object; so that its Eyes are quite independent on each other, and capable of all the different Motions that can be imagined. The Structure of its Eyes is also surprizing; for they are covered with a Skin almost like that of the Body, the Grain of which is in Circles, diminishing gradually to the Center, where is a Hole no bigger than the Head of a Pin, which receives the Light.

The common Colour of the *Chameleons* in *Smyrna* is green, toward the Belly inclining to a yellow. But those in the Ruins of the Castle are greyish, like the Stones among which they breed. One of them, having been kept in a Napkin, appeared whitish; but it never changed to red or blue, tho' wrapt in Cloth of those Colours for several Hours together. On being handled or disturbed, it became stained with

with dark Spots, bordering on green. Sometimes from a green all over, it became full of black Spots; sometimes when it appeared black, green Spots suddenly appeared. So far is it from being true, that it changed its Colour, according to every Object near it. Nor could we perceive this Change to be any fixt Law, it rather seemed spontaneous. This only was constant; being placed on green, it became green; being on the Earth, it changed to the Colour of Earth.

P. 178. In most Parts of *Italy* there are Swarms of *Lizards*, especially of the green Kind. In the Spring, Hundreds of them are seen, basking on the Roofs, and crawling up and down the Walls of Houses. They are very nimble, and have a bright, sleek Skin, and beautiful Eyes, but are entirely harmless. The *Scorpions* are not so; they harbour not only in old Walls and under Stones, but in every Part of the House, especially the Beds; and if touched, immediately sting. The Sting of an *Apulian* Scorpion, has the same Effect with the Bite of a *Tarantula*. And it requires the same Method of Cure; only by different Instruments, the Flute and Bagpipe in particular, with the brisk Beat of a Drum. But the common Remedy against the Sting of a Scorpion is, to bruise the Animal, and bind it on the Wound.

With Regard to *Water-lizards*, commonly called *Newts*, which most people suppose to be venomous, they are harmless as Land-lizards, and are found in Summer, in most shallow standing Waters. One who kept several of them in Glass Jars for many Months observes, in Respect of that odd Circumstance, casting their Skins, they do this every Fortnight or three Weeks. A Day or two before the Change, the Animal appears more sluggish than usual, and takes no Notice of its Food, which at other Times it devours greedily. The Skin in some Parts appears loose, and of not so lively a Colour as before. It begins

begins this Work, by loosening with its Fore-feet, the Skin about its Jaws, pushing it forward gently and gradually both above and below the Head, till it can slip out first one Leg and then the other. Then it thrusts the Skin backward as far as those Legs can reach. Next it rubs itself against Pebbles, Gravel or whatever else it can meet with, till more than half the Body is freed from the Skin; which then appears doubled back, covering the hinder Part of the Body and Tail. Then turning its Head round to meet its Tail, it takes hold of the Skin with its Mouth, and setting its Feet thereon, by Degrees pulls it off, drawing the Hind-legs out, as it did the Fore-legs. If you then examine the Skin, it will be found Inside outward, but without the least Hole or Breach, the Part which covered the hind Legs seeming like Gloves turned Inside out, tho' intirely perfect and unbroken. They do not however put off the Coverings of their Eyes, as most Kinds of Snakes do; for the Skin of the Newt has always two Holes, at the Places where the Eyes have been: When the Skin is off, if it be not soon taken away, the Creature swallows it whole.

Many Creatures of very different Kinds, put off their Skins or Shells at certain Periods, and if we may guess at other Shell-fish by the *fresh Water Shrimps*, their Shells are put off without any Breach but one, lengthways, in the Middle of the Belly part, thro' which the Body, Tail and Claws are pulled out, and the Shell left in a Manner whole. In the Insect Tribe, the Changes of Caterpillars are well known. The Spider throws off its Skin as frequently, getting out of it by a Rupture underneath, and leaving every Claw intire, and even the horny Covering of his Forceps. Even the Mite casts its Skin at several short Periods, and nearly in the same Manner.

A particular Species of Water-Lizard, Abbe Spallanzani terms an *Aquatic Salamander*. Yet he observes, this cannot bear any great Degree, either of Heat or Cold.

Cold. But the most remarkable Circumstance relating to it is, that let its Tail, Legs, or even Jaws be cut away, and in a short Time they are re-produced. The Tail, beside a compleat Apparatus of Nerves, Muscles, Glands, Arteries and Veins, has Vertebrae of real Bone. And their Legs do not differ from those of the most perfect Animals, in the Number of Bones, whereof they are composed. Now when the Legs and Tail of this Animal are taken away, new Vertebrae, new Bones are produced: A Phenomenon as wonderful, as any hitherto known. This takes Place in every known Species of Salamander, at any Period of their Life, on the Earth or in the Water; and let the Length of the divided Part be greater or less. Nor do the constituent Parts of the new Tail differ from those of the Part that was cut, either in Number, Structure, or Connection. But a whole Year is scarce sufficient to render the new Part equal to that which was cut off. Indeed the regenerating Power ceases during the Winter half Year.

When the Part re-produced is cut off, it is succeeded by another, which proceeds in the same Manner as the former, and this a second, a third, or a fourth Time: The Salamander still forming new Parts, by the same unalterable Laws.

There are in the Legs of a Salamander ninety and nine Bones. In the four regenerated Legs there is the same Number. The Form and internal Structure of the re-produced. Bones of the Natural, are the same. But the Colour of the new Bones is somewhat different, and their Substance more tender. And all these Parts are re-produced in the same Manner and the same Time, whether the Creature is fed, or kept fasting.

When their Jaws are cut off, the same Thing happens. New Bones are re-produced, new Teeth, new Cartilages, Veins and Arteries. From the wonderful Reproduction of so many Parts in this, may we not extend our Enquiry to other Animals of equally complicated Structure? Let us inquire first concerning

Tad-poles.

Tad-poles. If the whole of their Tails be cut off, they sink to the Bottom of the Water and perish. But if Part only, they soon recover it. In one Summer's Day, the Reproduction makes a rapid Progress in young Tad-poles. And in a short Time, the new Part of the Tail and the old together, equal the Tail of others born at the same Time. A second, third, and fourth Reproduction constantly follows, upon a second, third, or fourth Section. Nay successive Regenerations never fail, as long as the Tad-pole keeps its Tail.

If no Nourishment is given Tad-poles, they do not grow, nor are the Membranes of the Infant-state cast off. Yet the Tails cut off, will be reproduced, in nearly the same Time.

If the Head of an *Earth-worm* be cut off, a new Head is reproduced. Nay, if both the Head and the Tail are cut off from the middle Part, both of them are reproduced. Nor is this regenerating Power soon exhausted. A second Reproduction being cut off, is succeeded by a Third, this by a Fourth, that by a Fifth, and so on.

The same Thing takes Place in another Kind of Worm, little known, which he calls an *aquatic Boat-worm*. It is composed of Rings, like the *Earth-worm*, which it shortens or lengthens at Pleasure, and so moves from Place to Place. Toward the Head it is as large as the largest Goose-quill, and its Length is about a Span. It lives in shallow, clear Water, either stagnating or flowing gently, fixing its fore Part in the Mud, whence it is nourished. The back Part reaches the Top of the Water, and being stretched and hollowed, form a Kind of Boat on the Surface. Its Sides rise above the Water, so that none gets in. But on the least Agitation of the Water, the Insect immediately shuts up his Boat, and retires into the Mud. When the Motion is over, he again thrusts his Tail out of the Water, and makes his Boat afresh, which remains entire till he is disturbed again. And this he does not fail to make, though the Mud

Mud is removed, and he left with little Water. It seems the Organs of Respiration are placed in this Part, as they are in various Sorts of aquatic Animals.

These Worms are quicker in their Reproduction than Earth-worms. They more easily recover their Heads, as well as Tails, and this Power exerts itself throughout the whole Year.

The Case of the *Snail* may seem still more strange. It can first, reproduce its Horns. After they have been cut off, the Trunk becomes like a small Knob, whence springs a black Point, which is the Eye. The Trunk then increases in Length and Size, till it equals the former Horn.

If the Head be cut off, a new one succeeds; but in a singular Manner. If a Worms Head be cut off, the Reproduction is an intire organic Body, that is, a Part in Miniature exactly similar to that which was cut off. But what appears on the Trunk of a Snail, is not an intire organic Body, containing in Miniature all the Parts of the Head which were cut off: But these Parts grow Piece by Piece at different Intervals, and require Time to unite and consolidate into one Mass, resembling the original Pattern. For Instance. Sometimes the Reproduction is like a round, small Body, containing the primary Parts of the two Lips, and of the small Horns, which are united to the Mouth, and to the new formed Teeth. This round Body is placed on the Center of the Trunk. The large Horns and the fore Part of the Snail, which in the entire Animal are contiguous to the Head, are wanting. Another Trunk shews the larger Horn on the right Side, more than a Tenth of an Inch long, already provided with its Eye. Under this, at some Distance, the first Lineaments of the Lips appear. In a third Snail arise three Horns, two of which are of their natural Length, while the Third is but just above the Skin. Some shew nothing but the Trunk, without any Sign of Reproduction, although the Head was taken off at the same Time with that of the

others, from which are come forth such a Number and Variety of Organs: On the contrary in some Snails, there is no Difference between the old and the new Head; Only there is an ash-coloured Line, painting out exactly where the Head was cut off.

V. I. p. 178. Both the whole *Tape worm*, and every Part of it seems to be a compleat Animal. In every Joint there is a Mouth for receiving Food, and doubtless Organs for digesting it. Single Joints, as well as larger Pieces, are frequently voided alive. All those Pieces are almost equally turgid with Chyle. Now it is not probable, that a single Worm, should in voiding, be broke into so many Pieces; And had it been done some Time before, they would be emaciated. There seems then to be an Analogy, between this jointed Worm and knotted Grass; each Joint of which is a compleat Plant, and propagates itself. It is indeed a Zoophyton, a Plant-Animal, bred in Animal-Bodies. Since so large and frequent Detruncations, do not destroy the Life of it.

Not only Vegetables and Animals have their respective Insects, to which they afford Food as well as Habitation, but Stones themselves. These Kind of Worms, called *Lithophagi*, are a Proof of this. One might think it incredible, that these little Creatures should subsist by gnawing Stones. And yet nothing is more certain, these worm-eaten Stones being found almost every where. These are generally Lime-stones. Grit or Free-stone is seldom eaten in this Manner. Yet there is an antient Wall of Free-stone in the *Benedictine* Abby at *Caen* in *Normandy*, so eaten with Worms, that one may put ones Hands into many of the Cavities. The Worms are covered with a greenish Shell, having flat Heads, a wide Mouth and four black Jaws. And they lay their Eggs in those Cavities, which they gnaw in the Stone.



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| 1. <i>Of the Coya,</i> | 5. <i>Of Ants,</i> |
| 2. <i>Of the Death-watch,</i> | 6. <i>A Pennsylvanian Wasp-</i> |
| 3. <i>Of the Clorweb Caterpillar,</i> | <i>nest.</i> |

P. 187. **T**HERE is found in *America*, a Kind of Spider more mischievous than even the Tarantula, chiefly in the Valleys of *Neyba*, and others within the Jurisdiction of *Popayan*. It is called a *Coya*. It is much less than a Bug, and is of a fiery red Colour. It is found in the Corners of Walls and among the Herbage. On squeezing it, if any Moisture from it falls on the Skin of either Man or Beast, it immediately penetrates the Flesh, and causes large Tumours, which are soon followed by Death.

The only Remedy is, on the first Appearance of a Swelling, to singe the Person all over the Body with a Flame of Straw, or of the long Grass, growing on those Plains. This the *Indians* perform with great Dexterity, some holding him by the Feet, others by the Hands.

Travellers here are warned by their *Indian* Guides, if they feel any Thing crawl on their Neck or Face, not even to lift their Hand, the *Coya* being so delicate a Texture, that it would immediately burst. But let them tell the *Indian* what they feel, and he comes, and blows it away.

The Beasts which feed there, are taught by Instinct, before they touch the Herbage with their Lips, to blow on it with all their Force, in order to clear it of these pernicious Vermin. And when their smell informs them, that a *Coya's* Nest is near, they immediately

mediately leap and run to some other Part. Yet sometimes a Mule, after all his Care, has taken in a Coya with his Pasture. In this Case after swelling to a frightful Degree, it expires upon the Spot. Thus does even the irrational Creation groan and travail in Pain together, until it shall be delivered into the glorious Liberty of the Children of GOD!

V. 1. p. 188. Examining one Day, says Mr. — a Number of the *Eels in four Paste*, I placed the largest that I could find under the Microscope. In doing this I wounded it in the Belly. A long, slender Tube came out, which I then took for an Intestine. I imparted this to a Friend, who the next Day, cut one in two near the Middle. A great Number of seeming Ova came out: But to our Surprise, we soon found they were live Eels, though in different Degrees of Maturity. Some moved slowly: Others coiled and uncoiled themselves briskly. The most Mature strove to disengage themselves from their enveloping Membranes, frequently varying their Position, till at last they were at Liberty, and swam about like the Parent Eel. So what I first took for an Intestine was the Uterus. Hence it is plain, that these Eels are viviparous. Consequently, it is not true, that all Kinds of Animalcula are produced from Eggs floating in the Air.

P. 192. That Death-Watches do woo one another, but not always, we may learn from the Account of an accurate Observer. "As I was in my Study, I happened to hear what is called a *Death-watch*. Inclining my Head toward a Chair, I found it was beating there. The Manner of its beating was this. It lifted up itself on its hinder Legs, and extending its Neck, struck its Face upon the Sedge, which was bared upon its outward Coat, about the Length of Half an Inch. The Impression of its Strokes was visible: The outward Coat of the Sedge being deprest, where it had just been beating, for about the Compass of a
Silver-

Silver-penny. I am inclined to think, it beats for Food. There were several Places on the Sedge, where it had been at work, and where it had probably been sojourning for some Days.

Possibly the Insect may sometimes woo its Mate by bearing thus: But it was not the Case now. It had not any other of its own Kind near it: It seemed therefore to be preparing its Food. It was about a Quarter of an Inch long, of a dark dirty Colour, having a broad Helmet over its Head, which he can draw up under it, so that it is a notable Defence, against the Falls, to which he is continually exposed, creeping over-rotten and decayed Places.

The second Day after I took it, I opened the Box and set it in the Sun. It was soon very brisk, and crept nimbly to and fro, till suddenly it struck out its Wings, and was going to take its Leave; but on my shading it over, it drew in its Wings and was quiet.

This seems to be the smallest of the *Beetle* Kind. A Gentleman describes one of a very different Sort, in the Philosophical Transactions. "On the Removal of a large Leaden Cistern, I observed at the Bottom of it several black *Beetles*. One of the largest I threw into a Cup of Spirits, (it being the Way of killing and preparing Insects for my Purpose.) In a few Minutes it appeared to be quite dead. I then shut it up in a Box about an Inch and half Diameter, and throwing it into a Drawer, thought no more of it for two Months, when opening the Box I found it alive and vigorous, though it had had no Food all the Time, nor any more Air than it could find in so small a Box, whose Cover shut very close. A few Days before, a Friend had sent me three or four Cock-roaches. These I had put under a large Glass; I put my Beetle among them, and fed them with green Ginger, which they ate greedily; but he would never taste it, for the five Weeks they lived there. The Cock-roaches would avoid the Beetle, and seem frightened at his Approach: But he usually stalked along not at all regarding whether they came in his Way or

not.

not. During the two Years and an Half that I have kept him, he has neither eat nor drank.

How then has he been kept alive? Is it by the Air? There are Particles in this, which supply a Growth to some Species of Plants, as Sempervive, Orpine and House-leek: May not the same or the like Particles supply Nourishment to some Species of Animals? In the amazing Plan of Nature, the Animal, Vegetable and Mineral Kingdoms, are not separated from each other by wide Distances, but near their Boundaries, differ from each other, by such minute and insensible Degrees that we cannot find out certainly, where the one begins, or the other Ends. As the Air therefore nourishes some Plants, so it may nourish some Animals: Otherwise a Link would seem to be wanting, in the mighty Chain of Beings. It is certain Camelions and Snakes can live many Months without any visible Sustenance: And probably, not merely by their slow Digestion, but rather by Means of Particles contained in the Air, as this Beetle did; yet doubtless in its natural State, it used more substantial Food. So the Plants above-named thrive best with a little Earth, although they flourish a long Time, and send forth Branches and Flowers, when they are suspended in the Air.

Even in the exhausted Receiver, after it had been there half an Hour, it seemed perfectly unconcerned, walking about as briskly as ever. But on the Admission of the Air, it seemed to be in a Surprise for a Minute.

After I had kept him half a Year longer, he got away, through the Carelessness of a Servant who took down the Glass.

V. 1. p. 204. In the Beginning of May 1737, the Cornel-trees, near Monaghan in Ireland, appeared covered with small Caterpillars, employed partly in feeding on the Leaves, partly in crawling over the Bark of the Tree. Each as it crawled left a fine Thread sticking to the Bark. By the End of May, there was

not a Leaf on any of the Trees, except a few reserved for a curious Purpose. But instead of the Green, a white Cloathing covered the whole Bark, from the Ground to the Point of the smallest Twigs, and that so glossy, that it shewed in the Sun, as if it was cast in burnished Silver. Then they covered with the same all the Ash, Beech, Lime, yea the very Weeds in which grew near them.

But how did they travel from Tree to Tree? Many crawled along the Ground. But many had a quicker Way. They hung by their own Threads from the utmost Branches of the Tree, so that a small Breeze waisted them to the next Tree, as Spiders pass from one Bush to another.

As they made no Use of the Threads left behind them, probably they wrought for no other Purpose, than to rid themselves of that glutinous Matter, out of which it was spun.

In the Beginning of June, they retired to rest. Their Manner of executing this, was very ingenious. Some chose the under Side of the Branches, just where they spring from the Trunk, that they might be defended from the Water, which in a Shower, running down the Bark of the Tree, is parted by the Branches, and sent off on each Side. Here they draw their Threads across the Angle made by the Trunk and Branch, and crossing those with other Threads, make a strong Covering. Within this they place themselves Lengthways among the Threads, and rolling their Bodies round, spin themselves into little Hammocks, in the mean Time shrinking into half their Length. These Hammocks being suspended by the transverse Threads, do not press each other. That they may take up the less room, they lie parallel to each other, in the most convenient Order possible. Others, still more ingenious, fasten their Threads to the Edge of the Leaves which they had saved for that Purpose: And with that slender Cordage pulling in the Extreminies of the Leaves, draw themselves into a Kind of Purse, within which they form

form the same Sort of Work, and lay themselves up as above. They lay themselves up in great Numbers together, both because many were necessary to the Work of providing a common Covering, and also to keep one another warm, while preparing for the great Change.

Between the Worm thus laid up, and the Hammock inclosing it, there is a tough brown Shell, probably formed of some glutinous Matter, transuding through its Pores. In the End of June, they gnaw through the Shells and Hammocks, and come forth a most beautiful Fly. After its Resurrection, it needs no Food. Those that came out in a Room, lived long there, as the rest did abroad. After a while several of them discharged a Drop of brown Liquor, probably containing the Egg. But as it was not lodged in a proper Receptacle, it produced no Worm the next Year.

As the Cornel only supplies this Worm with Food, so it is the only Nurse of its Egg. There is not an Animal or a Vegetable, but yields Habitation and Food to its peculiar Insect. The Scheme of Life begins in Vegetation: And whenever Nature produces Vegetables, she obliges them to pay for their Nourishment, to certain Animals which she billets upon them. Each of these again, is to diet and lodge another Set of living Creatures. This just Community in Nature, which suffers nothing to subsist merely for itself, is found not only every where on the Earth, but likewise every where in the Waters. By Microscopes we discover an Infinity of little Creatures, feeding on the floating Vegetables, or on one another. Indeed as to the Sea, we know only what happens near the Shores, where we find Vegetables of various Kinds, which breed and nourish a like Variety of Insects. These, with a Multitude of others bred in the Mud, are the Prey of the smaller Kinds of Fish, and they again of the greater. That this Scheme of Nature, found every where else, dives into the Depths of the Ocean, we may gather from the wonderful Kinds of Fishes,

Fishes, washed up by the Storms now and then from the deep Waters.

Now it is on the *Cornel* alone, that the Worms we have spoken of can be propagated and fed. The specific Qualities with which its Juices are impregnated, are peculiarly suitable to this Insect. If these reside in the essential Oil of the Plant, this, as well as other Insects, subsisting on Vegetables, have the Skill to extract, nicer than any Chymist can do, the essential Oil of each Plant, nothing else therein being a Nature sufficiently peculiar, either to assist the Propagation, or supply the Nourishment of the Insect.

P. 208. Though *Ants* unite in Colonies, in such Places as are agreeable to their different Natures, yet they often vary their Residence. But the several Species never intermix, though they will be good Neighbours one to another.

Their Architecture is adjusted with remarkable Art. The whole Structure is divided into numerous Cells, communicating with each other by small subterraneous Channels, which are circular and smooth. They carry on all their Works by Means of their double Saws, and the Hooks at the Extremity of them.

A Colony from the latter End of August, to the Beginning of June, consists of a Female, and various Companies of Workers: And beside these in the latter End of June, all July and Part of August, of a Number of winged *Ants*.

The labouring *Ants*, being of no Sex, are wholly employed in providing for the Young, which the Queen deposits in the Cells. In whatever Apartment she is present, universal Joy is shewn. They have a particular Way of skipping, leaping, prancing, and standing on their hind Legs. Some walk gently over her, others dance round her, all express their Loyalty and Affection: Of all which you may be convinced in a few Moments, by placing the Queen and her Retinue under a Glass.

The

The Queen lays three different Sorts of Eggs, Male and Female in Spring, Neutral, in July, and Part of August. The common Ants then brood over them in little Clusters, and remove them to and fro, for a just Degree of Heat. The Young disengage themselves from their Membranes that enclose the Eggs, just as the Silk-worms do. The Female Eggs put on the Form of Worms, some Time in February; the Male, by the latter End of March, the Neutral, by September. The first Summer they grow little, and less in Winter. In the Beginning of April the second Year, they visibly increase every Day. By the End of May the Male and Female attain their full Growth, and are ready for another Change. This long Continuance of Ants in the vermicular State, has nothing like it in any other Class of Insects. The Vermicles in a few Days infold themselves in a soft, silken Covering, and so commence Aurelias, which are commonly mistaken for Ants Eggs. As soon as they tend to life, the Workers give them Air, by an Aperture in the End of the Covering. This they gradually enlarge for a Day or Two, and then take out their Young.

There is a larger and a smaller Sort of winged Ants, the latter Male, the former Female. Those Females, which escape being devoured by other Creatures, become Queens; and give Birth to new Colonies.

In all other Insects the Loss of their Wings lessens their Beauty, and shortens their Lives. But Ants gain by that Loss; this being the Prelude of their ascending the Throne.

The Young are fed by the Juices of most Sorts of Fruits, which the Labourers extract, and receive into their own Stomach; where they are prepared, and afterwards transfused into the tender Vermicles.

Perhaps in warm Climates, Ants do not pass the Winter in Sleep, as they do with us. If so, they need a Store of Food, which in our Climate is quite needless. Accordingly those who have accurately examined their most numerous Settlements, could never

never find out any Reservoir of Corn or other Aliments. And they that have carefully observed their Excursions from and Return to their Colonies, could never observe that they returned with any Wheat, Corn, or any other vegetable Seed: Though they would eagerly attack a Pot of Honey, or a Jar of Sweet-meats.

"But is it not said, *Prov. 6. viii. She provideth her Meat in the Summer, and gathereth her Food in the Harvest?*" It is: But this does not necessarily mean any more, than that she collects her Food in the proper Season. Nor is any Thing more declared, *ch. 30. 35.* than that Ants carry Food into their Repositories. That they do this against Winter, is not said: Neither is it true in Fact.

P. 208. After Foot deep.

If a Frog be put into a Box with Holes bored therein, and the Box laid near a Nest of Ants, they will entirely dissect him, and make the finest Skeleton possible, leaving even the Ligaments unhurt.

P. 215. There is a purplish Wasp in *Pennsylvania*, whose artful Contrivance is wonderful. And as if it were given to cheer them in their Labour, they make a particular musical Noise. Their Manner of Working is, to moisten Clay, and temper it up into a little Lump, of the Size of a Swan-shot. This they carry to build with. They begin at the upper End of the Cell, and work downward, till it is long enough to contain the Nymph. When they have spread out the Lump in a proper Manner, they set up their musical Note, and go and work up more Clay for the next Course. Thus they sing and work by Turns, till a Cell is finished, which is made delicately smooth within. At the farther End of each Cell, they lay an Egg: Then by a surprizing Instinct, they go and catch Spiders and cram the Cell full of them. But it is farther wonderful, they do not kill, but only disable

disable the Spiders, which is to answer two Purposes; first, that they should not get away; and next, that they may be preserved alive and fresh for the Food of the Young.

Of one Sort of *Ephemeron*, Mr. Collinson writes thus, May 26, 1744. I was first shewn this, by the Name of *May-fly*. It lies all the Year, but a few Days, at the Bottom of the River; then rises to the Surface of the Water, and splitting open its Case, up springs the new Animal, with a slender Body, four shining Wings, and three long Hairs in its Tail. It next flies about to find a proper Place, where it may wait for its approaching Change. This comes in two or three Days. I held one on my Finger, while it performed this great Work. It was surprizing to see, how easily its Back split, and produced the new Birth, which leaves Head, Body, Wings, Legs, and even its three-haired Tail behind, or the Cases of them. After it has rested a little, it flies nimbly to seek its Mate. The Males kept under the Trees, remote from the River. Hither the Females resorted, and when impregnated, soon left the Males, sought the Rivers, and kept continually playing up and down on the Water. Every Time they darted down they ejected a Cluster of Eggs. Then they sprang up again. Thus they went up and down, till they had exhausted their Stock of Eggs and spent their Strength, being so weak that they can rise no more, but fall a prey to the Fish. This is the End of the Females. The Males never resort to the River, but having done their Office, drop down and die.

In a Life of three or four Days, they eat nothing. They have no Apparatus for that Purpose, yet they have Strength to shed their skin, and to perform the Ends of their Life with great Vivacity.

But how poor an End, to our Apprehension, is answered, by the Life of this, and innumerable other Animals?

C H A P V L

General Observations.

1. *Of the cloathing of some Animals* || 2. *Of the Transformation of Animals.*

P. 216. **A**S Barnacles seem to be a Medium between Birds and Fishes, altho' they more properly belong to the former, so is a *Polypus*, (altho' it is doubtless an Animal) between Animals and Plants.

In a *Polypus*, Life is preserved, after it is cut into several Pieces, so that one Animal is by Section immediately divided into two, three or more compleat Animals, each enjoying Life and continuing to perform the proper Offices of its Species.

The common Operations both of the animal and vegetable World, are all in themselves astonishing. Nothing but daily Experience makes us see without Amazement, an Animal bring forth Young, or a Tree bear Leaves and Fruit. The same Experience makes it familiar to us, that Vegetables are propagated not only from the Seed, but from Cuttings. So the Willow-twig cut off and only stuck in the Ground, presently takes Root, and is as perfect a Tree as that whence it was taken. This is common in the vegetable Kingdom, and we have a rare Example of it in the Animal.

The *Polypus* is an aquatic Animal, to be found in Ditch-water. It is very slender, and has on the fore Part several Horns, which serve it for Legs and Arms. Between these is the Mouth; it opens into the Stomach, which takes up the whole Length of the Body.

G

Indeed

Indeed the whole Body is but one Pipe, a Sort of Gut which opens at both Ends.

The common Polypus is about three Quarters of an Inch long: But there are many Species of them. Some of which can extend themselves to the Length of six or seven Inches. Even in the same Species, the Number of Legs and Arms is not always the same; but they have seldom fewer than six. Both the Body and Arms may be inflated all Manner of Ways; and hence it is, that they put themselves into so great Variety of Figures.

They do not swim, but crawl on the Ground, or on any Body they meet with in the Waters. They usually fix their posterior End to some Thing, and stretch their Bodies and Arms into the Water. With these Arms they catch numberless Insects, which are swimming up and down. A Polypus, having seized his Prey, uses one or more Arms to bring it to his Mouth. He can master a Worm thrice as long as himself, which he swallows whole; and having drawn all that is nutritive from it, he then throws out the Skin.

I have cut a Polypus in two, between seven and eight in the Morning, and before three in the Afternoon, each Part was a compleat Animal, able to eat a Worm as long as itself. If a Polypus be cut Lengthways, beginning at the Head, but not quite to the Tail, there is a Polypus with two Heads, two Bodies and one Tail. Some of these Heads and Bodies may soon be cut Lengthways again. Thus I have produced a Polypus with seven Heads, seven Bodies and one Tail. I cut off the Heads of this new Hydra, seven others grew up, and each of these cut off, became a Polypus.

I cut a Polypus cross-ways into two Parts: put them together again and they re-united. I put the posterior Part of one, to the anterior of another, they soon united into one Polypus, which ate the next Day, and soon put forth young ones, from each Part.

"As the Body of a Polypus is but one Gut, I have turned it inside out. The Inside soon after became the Outside, and it fed and multiplied as before. They do not copulate at all; but each Polypus has the Faculty of multiplying itself: Yea, before it is severed from its Parent. I have seen a Polypus while growing out of the Side of its Parent, bring forth young ones: Nay, and those young ones themselves have also brought forth others.

Cut a Polypus across, and the same Day the anterior End Lengthens itself, creeps and eats. The lower Part which has no Head, gets one, forms itself a Mouth and puts forth Arms. It is all one, in whatever Part the Body is cut; cut it into three or four Parts, and each becomes a compleat Polypus.

Cut one Lengthways, splitting it quite in two so as to form two half Pipes. It is not long before the two Eyes of them close, they begin at the posterior Part, and close upward, till each half Pipe becomes a whole one. All this is done in less than an Hour, and the Polypus produced from each of those Halves, differs nothing from the First, only it has fewer Arms. But these too are soon supplied!

But as strange Animals as all Polypi are, the *clustering Polypi* are more strange than the Rest. One species of these are of a Bell-like form. Their anterior Part, in which is their Mouth, is hollowed inward, and resembles the open End of a Bell. Their other Extremity ends in a Point, to which is fixt a stalk or Pedicle. The Polypus when it is ready to divide, first draws in its Lips into the Cavity, it then Degrees grows round; and presently after divides itself, into two other round Bodies. These in a few moments open, loose their Spherical Form, and put that of a Bell, or compleat Polypus. This is the manner in which clustering Polypi are multiplied. The whole Operation is performed in three Quarters of an Hour. The Cluster which they form, rests upon a Stem, which is fixt to some other Body at its lower Extremity, and from its other arise Branches:

Other Branches again shoot out from these in different Places; from these last other new ones, and so on. At the Extremity of each Branch is a Polypus. The Assemblage of all these Branches with the Polypi at their Extremities, form a Cluster much resembling a Tuff of Flowers. The Stem which carries all the Clustre, is capable of a remarkable Motion, each Branch contracts when it is touched: Each can contract itself alone, tho' this seldom happens, for in contracting it commonly touches another, which then immediately contracts with it. When the main Stem which bears the whole Cluster contracts, all the Branches contract together, and the whole becomes intirely closed. A Moment after, the Branches and the Stem again extend themselves, and the whole Cluster recovers it ordinary Figure.

A Cluster is formed thus: A single Polypus detaching from the Cluster, swims about in the Water, till it meets with some proper Body, to fix itself upon. It then has a Pedicle, but which is no longer than the Polypus itself; but it becomes eight or nine Times as long in four and twenty Hours, and is to be the main Stem of the new Clustre. In a Day after it is fixt it divides itself into two, each of which in a few Hours divides into two more. These soon after put out Branches, and all this is re-iterated several Times. Thus a principal Branch is formed, provided with several lateral ones, which afterwards become principal ones, with Regard to others that spring from them.

When a Cluster is nearly stript of its Polypi, the Branches are no longer able to contract. When but a few Polypi remain, none can contract but those which they are fixt. Hence it appears, that the Motion in the Stem and Branches of a Cluster, is entirely derived from the Polypi. Indeed at first Sight one would imagine, that the Polypi fixt to the Branches of the Cluster, spring from them, in the same Manner as the Leaves, the Flowers, and the Fruit of a Vegetable spring from it. On the contrary

the Branches composing the Clusters of Polypi, spring from the Polypi, which are at their Extremities, and these Polypi, which at first appear to be Fruits, may rather be termed the Roots of them.

The Nature of Corallines, and the Mechanism of their *Polypi*, (says Dr. *Peyssonel*) made me conjecture, that it was the same with Respect to *Sponges*; that Animals nested in the Intestices of their Fibres, gave them their Origin and Growth: But I had not yet seen the Insects. Sponges appeared to me only as Skeletons, and I at length discovered the Worms which form them. They are of four Species, 1. The Tube-like Sponge. 2. The Cord-like Sponge. 3. The fingered Sponge. 4. The Honey-comb Sponge.

These four Kinds only differ in Form, they have the same Qualities, and are made by the same Kinds of Worm; they are all composed of hard, firm, dirty Fibres, sometime brittle, separated one from another, having large hollow Tubes dispersed thro' their Substance, these Tubes are smooth within. These Fibres, which consist of the twisted Doubles of the Sponge, form as it were a Labyrinth filled with Worms, which are easily crushed; but having carefully torn the Sponges, and their gross Fibres, I discovered the living Worms.

These Species of Sponge commonly grow upon sandy Bottoms. At their Origins we perceive, a Nodule of Sand, or other Matter, almost petrified, round which the Worms begin to work, and round which they retire, as to their last Refuge, where I had the Pleasure of seeing them play, exercise themselves, and retire, by examining them with the Microscope.

The Worms are about one third of a Line thick, and two or three Lines in Length. They are so transparent that one may discern their Viscera through their Substance, and the Blood may be seen to circulate. They have a small black Head, furnished with two Pincers; the other Extremity is almost

Square, and much larger than the Head. Upon the Back may be seen two white Streaks, as if they contained the Chyle: These two Canals are parallel to each other from the Head to the other Extremity, where they come together. In the Middle where the Belly and Viscera ought to be placed, a blackish Matter is perceivable, which has a Kind of Circulation; sometimes it fills all the Body of the Worm, sometimes it gathers towards the Head, or at the other End, and sometimes it follows the Motion of the Animal. This vermicular Motion begins at the posterior Extremity, and ends at the Head. They have no particular Lodge, they walk indifferently into the tubular Labyrinth. These Sponges are attached to some solid Body in the Sea. Some Kinds are fixed to Rocks, others to Heaps of Sand, or to Pieces of petrified Matter; and the Sea putting in Motion the Sand, and the little Parcels of broken Shells, forces them into the Holes of the Sponge.

So far the Doctor. But still I doubt, whether the Worms form the Sponge, or only lodge therein.

The same Doubt I have with Regard to what follows. "The *Bekinnites* is a Fossil, a Kind of stony Shell, which has hitherto perplexed the Naturalists of all Countries. Strait ones are common in Sweden, Livonia and Germany, those that are curved are more common in France and England. The Nucleus of it seems to be a strait concamerated Shell, which is surrounded by a huge, solid Substance. Now how was this formed? And how is it that some have a Nucleus, others not? Again, how is it that in some the Cavities containing it, is very small, in others not visible?"

In order to understand this, we may consider, that many Bodies which we always took for Vegetable, are really Animal. So the several Coralline Substances, hitherto reputed Marine Plants, are now generally believed, to be the Shells of Polypi. Is it not then highly probable, that the testaceous Tribe in general are generated like Flies, the latter from a

Maggot,

Maggot, the former from a Polypis ? It must be so with many : And as Corals in general seem to be constructed by Polypis, are they not the primary State of all, or most of the testaceous Tribe ? If so, it is almost beyond a Conjecture, that the Body called a Belemnites (which on being put into Acids is found to ferment in like Manner as Corals) is formed likewise by a Polypis, from which the Nucleus seems to be the last State. And does not this concamerated Body of which the Belemnites is only the Habitation, lead us into the Connexion and Manner of Generation (perhaps particular to the testaceous Tribe) by remaining within its Nidies all its Life, whereas the Generality quit their Nidi as soon as they are able to shift for themselves.

The Polypis is an Animal of the Vermicular Kind ; the Bodies of some are long and slender, like a fine Fibre, extremely tender, and from the Head proceed a Variety of Claws or Arms, with which it catches its Food, and prepares its Habitation. They are of various Shapes and Textures according to the Species of the Animal that is to proceed from them ; and very wonderful it is, how so small an Animal should form so large a Body as the Belemnites ! some Animals in the terrestrial Part of the Creation, naturally associate together, others seek Solitude. The same Dispositions we find in the aquatic, then why not among the Polypis ? Is not this evidently seen from the Variety of Coral Bodies ? It seems in some as if Thousands acted in Concert together ; in others each acts for itself ; of which latter is the Belemnites. The Shape of the Belemnites is generally Conic, terminating in a Point, and of various Colours, according to the Juices of the Stratum in which it lay ; it has usually a Seam running down the whole Length of it. Its interior Constitution seems composed of several Crusts, which when broken transversely proceed on Rays from the Seam to the Centre. This Seam I take to have been the Habitation of the Animal in its Polypi State, and in which the Body was affixed. The Animals of the testaceous Tribe in general,

general, as they increase in Age, increase their Shells in thickness, until they have lived their stated Time, and that is done by adding a new Crust to, as several, if not all the Tubuli, the Oysters, and the Nuttli witness. By Length of Time they grow inactive and dead, the Effect of extreme old Age, suffering other Marine Bodies, as Worms, Oysters, to affix themselves to their outer Coat. The like Appearance we frequently meet with on Belemnites when the Animal within was either waxed old, or dead.

One might enlarge upon the Analogies which may be found, between the Origin of these minute Animals, the Origin of Plants, and that of those other Animals which we are more acquainted with. But we shall be better able to judge of those Analogies, when we come to know more both of Plants and Animals.

The surprizing Facts which the Study of Natural History lays before us Day by Day, may convince us, that the Nature of Plants and Animals, is as yet but very imperfectly known: Indeed much more imperfectly, than many have been apt to imagine. All we know is very little, in Comparison of what remains unknown. And this Consideration, as it should prompt us, still more diligently to enquire after Truth, so it should make us exceeding cautious, how we judge of the Nature of Things, from so few Principles as we are at present Masters of.

P. 222. All the Animals near *Hudsons-Bay*, are cloathed with a close, soft, warm Fur. But what is still more surprizing, and what draws all attentive Minds to admire the Wisdom and Goodness of Providence, is that the very Dogs and Cats which are brought thither from *England*, on the Approach of Winter change their Appearance, and acquire a much longer, softer and thicker Coat of Hair than they originally had.

One Circumstance more is worthy our farthest Observation, with Regard not only to Insects, but in
some

some Measure to the whole Animal Creation, namely the various *Transformations* they undergo. Those kinds of Animals which are viviparous, which produce their Young alive, undergo the lightest Alteration; yet even these have some. Growth itself is the lowest Step of this Ladder: And this is common to all Animals. Man himself, lordly as he is, at his perfect Growth, is not only the most helpless at his Birth, but continues so longer than any other Member of the Animal World. However, except that of Growth, he undergoes no considerable Alteration in this Life.

Quadrupeds undergo a greater Change yearly, by the loss and renovation of their Outward Covering. This Change however is gradual and almost insensible, the latter being of the same Substance, and even Colour as the Former. But there is an Exception to this, in those which undergo this Change twice in the Year, as do the Bares, Hares and Foxes in *Greenland* and other extremely cold Countries: And the *Ermins*, which are frequent in *Yorkshire*, and several other Parts of *England*, their Hair changes white at the Approach of Winter, and in Spring resumes its former Colour.

One Class however of Viviparous Animals undergo a more sudden Alteration, namely, the Serpent Kind. These having no Hair or Fur to lose gradually, cast their whole Covering at once, and are so dextrous therein, tho' they have neither Feet nor Claws, yet their whole Skins are frequently found entire, without even the Cornea or outward Case of the Eyes which accompanies the other *Exuviae*, being broken.

Next to these are the Oviparous Animals, these make their first Appearance in a State of intire Inaction, but being gradually ripened by natural or artificial Heat, burst out, some in their compleat State, as Lizards, Spiders and Fish in general; and others, as Birds, requiring like viviparous Animals, the addition of the extrementious Parts. Almost all the
Species

Species of these which we know, need the same farther Change with the Viviparous. All Birds moult their Feathers, and many in cold Countries change the Colour of them in the Winter. Lizards drop their Skins, like Snakes; one Kind of them, Water Newts, every two or three Weeks. Spiders, Crabs and all whose outward Covering is crustaceous, and therefore incapable of distension, cast their Shells once a Year, at which Time Nature provides them with such supplementary Juices, by a Kind of Exudation from their Pores, as form a new Shell beneath.

Proceed we to those Animals, whose Transformations are more compleat, which being fully posselt of Life in one Figure, afterwards assumes another, or being first in One, afterwards inhabits a quite different Element.

To give an Instance of each. The Egg of a Frog being laid in the Water, produces a lively Animal which we call a Tadpole. He has a thin slimy Tail, which steers him in the Water, in which he wholly resides. But after a while, Legs and Feet burst thro' the Skin; the Tail drops off, he is a perfect Quadruped. He leaps upon the Earth and ranges over that Ground, on which some Time since it would have been Death to him to be cast.

The Beetle Class is an Instance of the other Change, and particularly the Cock-chaffer. The Female deposits her Egg below the Surface of the Earth, which hatches into a Grub, with two or three Pair of strong Forcipes, whereby it is enabled to force its Way through the Mould where it was lodged, and to cut and tear in Pieces for its Nourishment any small Roots which come in its Way. After staying here two whole Years, a shelly Covering forms over its soft Body, a Pair of fine Wings grow on its Back, to secure which from Danger when not used, a Pair of strong Cases are provided. And now forcing his Way out of the Ground, he becomes a lively Inhabitant of the Air.

PART



Part the Third.

Of Plants and Fossils.

C H A P I.

Of Plants.

- | | |
|-------------------------------------|---|
| 1. <i>Of the Bark,</i> | 8. <i>Of Holly,</i> |
| 2. <i>Of the Root,</i> | 9. <i>Of the Sleep of Plants.</i> |
| 3. <i>Water is not the Aliment</i> | 10. <i>Trees inverted will grow,</i> |
| <i>of Plants,</i> | 11. <i>Seeds of Missleto,</i> |
| 4. <i>Sap both descends and as-</i> | 12. <i>— of Strawberries and</i> |
| <i>cends, even in Winter,</i> | <i>Raspberries,</i> |
| 5. <i>How the Sap ascends,</i> | 13. <i>— of Moss,</i> |
| 6. <i>Of the Increase of Grain</i> | 14. <i>Husbandry of Figs,</i> |
| <i>and Seeds,</i> | 15. <i>— of Mahogany,</i> |
| 7. <i>Of Male and Female</i> | 16. <i>Of Grain, &c. planted in</i> |
| <i>Plants,</i> | <i>Moss,</i> |

V. I. p. 28. **P**ERHAPS the Bark in Fruit Trees is principally designed for the Augmentation of the Tree itself, while the finer Vessels of the Woody Part, strain and prepare the Juices for the Fruit. A Gentleman near Cork, observing that his Peach-tree grew exceedingly, but bore no Fruit, cut off the Bark almost quite round, for the Breadth
of

of two Fingers. The next Year the Tree hardly grew at all, but bore Abundance of Fruit.

P. 239. If no Moisture come to the *Roots* of Trees, they cannot grow; but if it comes only to the Points of the Root, though all the rest remain dry, they grow well. For the Root shoots out yearly a sharp-pointed tender Part, somewhat like the sharp Bud on the End of a Sprig, by which it not only enlarges itself in Breadth, as the Branches do above, but also receives its Nourishment. And that tender Part moves toward the soft and moist Earth. So that to loosen the Earth at the Points of their Roots, much helps the Growth of all Plants.

P. 240. It is remarkable, the Trees of the most different Kinds, draw their whole Sustainance from the Moisture they find in the same Piece of Ground, and from the ambient Air and Dews. Hence we may infer, that the very Contextures of their Bodies from the first Seed, are the natural Limbes, where the common Water and Air, are digested into so many different Leaves and Fruits.

We see also, that an handful of Moss, sometimes above a Span long, grows out of a small Oyster-shell, without any Earth, as do Trees out of bare Rocks. Hence we easily learn, that the Seeds first, and then the Roots, Stems and Leaves of Trees, are the Strainers which secrete and generate their peculiar Saps and Juices. These are at first little else than pure Air and Water, till they are concreted into peculiar Salts, by more curious Strainers and more subtle Boilers than Art has ever devised.

The Antients generally supposed the Earth to produce Vegetables; but this many of the Moderns ascribe to Water alone, just as well, as if planted in Earth. But it is a Doubt, wither that Experiment ever was made with the Nicety that is requisite. However it proves nothing, unless that Water be quite pure from any terrestrial Mixture. For if it be

not

not, the Plant may owe its whole Growth to that terrestrial Matter.

Who can find any Water, newly taken out of the Spring, which does not exhibit even to the naked Eye, great Numbers of small terrestrial Particles, dispersed through every Part of it? These are of two general Kinds. Some are of a mineral Nature, others of a Vegetable. Of the latter some are fit to nourish one Plant, or one Part of it, and some another. All Water is much charged with vegetable Matter, which is fine, light and easily moveable. Spring-Water contains more of Mineral than River Water, River Water more than Rain Water.

To which of these Waters, or the Matter sustained therein, do Vegetables owe their Growth? In order to decide this, the following Experiments were made. Several Phials of the same Shape and Size were filled with equal Quantities of Water. Over each was tied a Piece of Parchment, with an Hole in it just large enough for the Stem of a Plant, to prevent the Water from evaporating, or ascending any Way but through the Plant. Several Plants being exactly weighed, were then placed in these Phials, and as they imbibed the Water, more was added from Time to Time. Each Glass was marked with a different Letter, and all set in the same Window, from July 20, till October 1. Then they were taken out, the Water in each Phial weighed, and the Plant with the Leaves that had fallen off. It then appeared how much each Plant had gained, and how much Water had been expended upon it.

H

Letters



Letters on the

	Weight of the Plant put in. gr.	Weight when taken out. gr.	Weight gain- ed in 77 Days.	Expence of Water.	Proportion of the Increase to the Expence of Water.
A. Spear-mint set in Spring-water.	27	42	15	2558	1 to 170
B. Spear-mint in Rain-water.	28	45	17	3004	1 to 171
C. Spear-mint in Thames-water.	28	54	26	2493	1 to 95
D. Nightshade in Spring-water.	49	106	57	3708	1 to 65

The Water ascends through the Vessels of Plants, through a Filtrre. And a larger Filtrre draws more Water than a smaller. Therefore Plants that have more or larger Vessels, draw more than those that have fewer and smaller.

But the greatest Part of the Water imbibed by Plants, passes through their Pores into the Atmosphere. Hence the least Proportion of Water expended to the Increase of the Plant, is at 46 or 50 to one. In some it is 100, 200, nay in one, 700 Times as much as the Increase of the Plant.

Nor does this Water pass off alone, but bears with it many Particles of the Plant. The Groisser indeed are not so easily borne up into the Atmosphere, but are usually deposited on the Surface of the Flowers, Leaves, or other Parts of the Plant. Hence our Honey-dews, and other gumous Exudations. But the finer easily ascend into the Atmosphere, and are conveyed to our Organs of Smell.

Great Part of the terrestrial Matter mixt with the Water, ascends into the Plants. After the Experiment, there was much more of it in the Glasses which had

had no Plants in them, than in those that had. I indeed this Matter, being so fine and light, attends Water in all its Motions: So that fitter it ever so often, some will remain.

The Plant increases more or less as the Water it stands in, contains more or less of this Matter. So the Mint in the Glass C, was of much the same Bulk and Weight with those in A and B. But standing in River-water, which contained more terrestrial Matter, than the Spring or Rain-water wherein they stood, it increased almost double to either of them, yea and with less Expence of Water.

But all vegetable Matter is not proper for the Nourishment of every Plant. Although some Parts in all may owe their Supply to the same common Matter, yet others require a peculiar Sort of Matter, and cannot be formed without it. Yea different Ingredients go to the Composition of one and the same Plant. If therefore the Soil wherein a Plant is set, contains all, or most of those Ingredients, it will grow there, otherwise not. If there be not as many Sorts of Particles, as are requisite for the essential Parts it will not grow at all. If they be there, but not enough of them, it will not grow to its natural Stature. If the less essential Particles be wanting, it will be defective in Smell, Taste, or some other Way. But though some Land may contain Matter proper for some Plants, yet it may for others. All this shews, that Plants owe their Increase, not to Water only, but to a particular terrestrial Matter: Else there would be no Need of Manure, or of transplanting them from Place to Place. The Rain falls on all Place alike: On this Field and that, this Garden or Orchard and another. Vegetables therefore are not formed of Water. One Plant draw up 300 Grains of this; yet increased only three Grains and a Half. The Mint in B. took thirty-nine Grains of Water a Day, which was much more than the whole Weight of the original Plant, And yet it gained not one-fourth of a Grain, in a Day and Night.

Water then is only a Vehicle to the terrestrial Matter, which forms Vegetables. Where this is wanting, the Plant does not increase, tho' ever so much Water ascend into it. This is only the Agent, which conveys that Matter to them, and distributes it to their several Parts for their Nourishment. It is fitted for this Office, by the Figure of its Parts, which are exactly spherical; therefore easily susceptible of Motion, and consequently capable of conveying other Matter that is not so voluble. Then the Intervals of Bodies consisting of spherical Particles, are the largest of all others, and so more fitted to receive foreign Matter. Besides the constituent Particles of Water are absolutely solid, and do not yield to the greatest external Force: Therefore their Intervals are always alike. By this quality Water is disposed to receive Matter into it: By the former, to bear it along with it.

It is farther qualified to be a Vehicle of this Matter, by the Fineness of its Particles. We scarce know a Fluid in Nature, except Fire whose constituent Parts are so exceeding small. They pass Pores which Air itself cannot pass. This enables them to enter the finest Vessels of Plants, and to introduce the terrestrial Matter to all Parts of them; each of which, by Means of peculiar Organs, assumes the Particles suitable to its own Nature, letting the rest pass on through the common Dusts.

P. 241. Earth is certainly, &c.

That the Sap *descends* in Winter, appears from hence, that the Graft will either corrupt or heal the Stock. Nay, it changes the very Way of the Growing of the Root, which it could not do, but by sending down its Sap thither. Crab-stocks grafted with Fruit, which the Soil does not like, will canker, not only in the Graft, but the Stock also. But graft them again with Fruit it does like, and it will quickly heal. Farther: Graft twenty young Pear-stocks with

with one Sort of Pear, and twenty with another. The Roots of one Sort will grow all alike, and so will those of the other.

Evergreens grafted on Trees which drop their Leaves, as the ever-green Oak of *Virginia* upon the common *English* Oak, hold their Leaves all the Winter. Does not this shew, that the Juices ascend in Winter, as well as Summer, even in the Plants which drop their Leaves? Otherwise those grafted on them must soon die.

It seems that the Sap does not rise by the Pith: because some large Trees are without that Part, and yet continue to put forth Branches. Indeed no Pith is found in those Branches of a Tree, which exceed two or three Years Growth. And the Pith which is in a Branch of this Year, is distributed into those Boughs which are formed the next Season.

Many believe, the Tree does not receive its Nourishment by the Bark; because Trees that have lost that Part, continue to grow. But they suppose a Tree has but one Bark; whereas every Branch has four distinct Coverings. The two outermost of these may be taken from a Tree without much Damage. But if the two others be taken off, it will infallibly kill the Tree.

Some affirm, that the Sap neither rises nor falls in the woody Part of the Tree, because when a Branch is cut, they cannot discern any Sap issue out of it. Certainly they cannot; because those Tubes are not large enough, to receive any Thing more gross than Vapour. The Root receives, chiefly in Autumn its proper Juices, which the Warmth in Spring raises into a Vapour, that gradually ascends through those fine Tubes, and by that Means causes Vegetation.

Some have objected to our Lord's speaking of Corn increasing an *Hundred Fold*, that this is impossible. So far from it, that a Grain of Barley, has been known to produce 249 Stalks, containing above 18000 Grains.

A still more curious Experiment was made with Turnip Seed, at *Sutton Coldfield*, in *Warwickshire*. In less than three Days after it was sown, the Turnips were above Ground. In three Weeks the Roots were as big as Walnuts: In less than five Weeks, as large as Apples. August 19th, one of them weighed 2 lb. 14 Oz. At the same Time was weighed an Ounce of the Seed, which had been sown, and it was found to contain 14600 single Grains. This being multiplied by 46 (the Ounces that the Turnip weighed) produces 671600, viz. the Number of single Grains required to equal the Weight of the Turnip. Hence it follows, that (supposing the Increase was uniform) the Grain, when it was sown, weighing but $\frac{1}{46}$ th Part of an Oz, increased in the following Proportion:

In Six Weeks	671600	} Times its own Weight.
A Week	111933	
A Day	15990	
An Hour	660	
A Minute	11	

Mr. Miller separated the Male Plants of *Spinach* from the Female. The Seed swelled as usual, but did not grow when he sowed it. Yet it might have been impregnated another Way, as appeared from another Experiment. He set twelve Tulips about six Yards from any other, and as soon as they flowered, carefully took out the Stamina. Two Days after he saw Bees working on other Tulips, and coming out loaded with the Dust. They flew into the first Tulips, and left therein Dust enough to impregnate them, which accordingly bore good Seed. Thus we see the Farina may be carried by Insects, and lodged on Flowers, which it is fit to impregnate.

Afterwards he bought and sowed some *Savory Seed*, and planted out the Plants, but was surprized at the Production. For he had some red Cabbage, some white, some Savoy with red ribs, and some a Mixture of all together in one Plant. The Gardener assured him, he had carefully sowed the Seed. Being

asked,

asked, where he had set the Plants for Seed, he shew-
ed him, and said, He planted first a Dozen white
Cabbages, next a Dozen Savoy's, and then a Dozen
red Cabbages. Is it not plain, that here the Effluvia
of one Sort, impregnated the other? For did each
Grain of the Farina impregnate only its own Kind,
this mongrel Sort could never be produced.

An Instance of the same Kind has been observed,
with Regard to *Indian Corn*: This is of several Co-
lours, as white, red and yellow. If each of these
be planted by themselves, they produce their own
Colour. But if you plant the blue Corn in one Row,
and the white or yellow in the next, they will inter-
change Colours: Some of the Ears in the blue Corn-
rows, are white or yellow, and some in the white or
yellow Rows are blue. That this is caused by the Ef-
fluvia of one impregnating the other, is manifest from
hence. Place a Close, high Fence, between the Corn
of different Colours, and there is no Change of Co-
lour in any of them.

P. 105. The *Holly* is described by all Naturalists,
as bearing hermaphrodite Flowers. But by late Ob-
servations it has appeared, that some Trees bear Male,
some Female Flowers. Yet there is a vast Variety.
In Chelsea Garden, some Hollies bear Female, some
hermaphrodite Flowers. But some Trees bear only
Male flowers; some only Female, some only Herma-
phrodite. Others bear both Male and Female, both
Male and Hermaphrodite or Female and Hermapro-
dite. And others bear Male, Female, and Herma-
phrodite, all at the same Time.

P. 105. *Acosta* and *Prosper Alphinus*, who both wrote
near the Conclusion of the sixteenth Century, are
the first, who recorded that Nocturnal Change in the
Leaves of Plants, which has since been called *Sleep*.
It is now many Years since *Linnaeus* first attended to this
Quality in Plants. In his *Flora Lapponica*, he re-
marks, that the Leaves of many, were subject to this
Change

Change in the Night Time: And he had then found, that heat and cold were not the Cause of this Quality; since they were alike influenced by it when placed in Stoves, where the Temperature of the Air was always the same. The Subject of the Sleep of Plants cannot but be entertaining to the Lovers of natural Knowledge: And such, cannot be less entertained with that Faculty, which *Linnaeus* calls the *awaking of Flowers*. Previous to our Explanation of this, we may observe, that the Flowers of most Plants, after they are once opened, continue so Night and Day, until they drop off, or die away. Others, which shut in the Night-time, open in the Morning sooner, or later, according to their Situation in the Sun or Shade, or as they are influenced by the manifest Changes of the Atmosphere. There are another Class of Flowers, which make the Subject of these Observations; which observe a more uniform Law in this Particular.

These open and shut constantly at certain Hours, exclusive of any manifest Changes in the Atmosphere; and this with so little Variation in Point of Time, as to render the Phenomenon worth Observation. *Linnaeus's* Observation extends to near fifty Species which are subject to this Law. We will enumerate some of these, and mention the Time when the Flowers open and shut. The Flowers of the *Male Pimpernell* open about eight o'Clock in the Morning, and never close till past Noon. This Plant is common in Kitchen Gardens and in Corn-fields, and flowers in June, and continues in Flower three Months. The little blue *Convolvulus*, or *Bindweed*, opens its Flowers between five and six in the Morning, and shuts them in the Afternoon. The Flowers of the *Day-lily*, open about five in the Morning, and shut at seven or eight in the Evening. The *lesser Water-Plantain*, during its flowering Time, only opens its Flowers each Day about Noon. The Flowers of *Proliferous Pink*, expand about eight in the Morning, and close again about one in the Afternoon. *Purple Spurry*, expands between nine and ten in

in the Morning, and closes between two and three in the Afternoon. This little Plant is common among the Corn in sandy Soils, and flowers in June. *Common Purslain*, opens its Flowers about nine or ten in the Morning, and closes them again in about an Hour's Time. *The white Water-Lilly* grows in Rivers, Ponds, and Ditches, and the Flowers lie upon the Surface of the Water. At their Time of Expansion, which is about seven in the Morning, the Stalk is erected, and the Flower more elevated above the Surface. In this Situation it continues till about four in the Afternoon, when the Flower sinks to the Surface of the Water, and closes again. *Yellow Goats Beard*, or *Go-to-bed-at-noon*. The latter of these Names was given to this Plant long since, on account of this remarkable Property. The Flowers open in general about three or four o'Clock, and close again about nine or ten in the Morning. These Flowers will perform their Vigiliæ, if set in a Phial of Water, within Doors for several Mornings successively. Sometimes they are quite closed, from their utmost State of Expansion, in less than a Quarter of an Hour. It flowers in June. *Tree Spoutistle*, expands its Flowers about six or seven, and closes them between eleven and twelve in the Forenoon.

This is common in Corr-fields, and flowers in June, July, and August. *Garden Lettuce*, opens its Flowers about seven, and closes them about ten, in the Forenoon. *Dandelion* expands at five or six, and closes at eight or nine, in the Forenoon. This Flowers early in the Spring, and again in Autumn. *Rough Dandelion*, opens its Flowers about four in the Morning, and keeps them expanded till three in the Afternoon. *Yellow Devil's-bit* opens about seven, and keeps in an expanded State till about three in the Afternoon. It flowers in July and August. *Common creeping Mousser* opens about eight in the Morning, and closes about two in the Afternoon. It is very common on dry Pastures, flowering in June and July. *Wild Succory* grows on the Borders of Fields, flowering in August and

and September. The Flowers open about eight in the Forenoon, and keep expanded till about four in the Afternoon. *Wild Marigold* expands from nine in the Morning till three in the Afternoon.

P. 254. If the Top of a *Viburnum* is planted in the Ground, it becomes Roots, and the Roots turned up become Branches; and the Plant grows exactly as well as it did in its natural Position: Whether the Vessels which fed the Branches have changed their Course, or whether the Juices go up and down in the same Vessels.

P. 256. The Berries of *Mistle* have within their viscid Pulp, a Kernel covered with a thin, whitish Skin. One placed these Berries within the Bark of Oak, Ash, Beech, Pear and Apple-trees, by making several Cuts in the Sides of the Trees, but the whole Berries would not stay in any of them. And when he broke them, the Seed always slipped out to the Edge of the Cut, and there stuck to the Bark by its viscid Covering. He stuck one Seed to the Bark without any cutting at all, which succeeded best, and yielded two Plants. The viscid Matter drying away, drew the Seeds close to the Bark, and on these with two more on an Apple tree and one on a Pear-tree, there began in Spring to shoot out at the End of the Seed next the Eye of the Berry, a small deep-green Shoot, like a little Clasper of a Vine. At first it rose upward, then turning again, swelled out somewhat bigger round the End; yet leaving the Tip quite flat, forming as it were, a Foot to stand upon. This Foot in June came to the Bark, and fast itself thereon. Being thus fastened at both Ends, it formed a little Arch, whose Diameter was as long as the Seed. Thus it remained till March following. Then the other End let go its Hold, and rising itself upward became the Head of the Plant, while the End which sprang out first, became the Root. 'Tis not uncommon, for the Seeds of Evergreens to be two Years before they spring

spring out of the Ground. But this was surprizing, the Change of the Ends, first one shooting out, and then the other. Yet we find Nature is uniform, and even in this strange Plant, acts as in other Vegetables, first carrying the Sap to form the Root, then turning the Course of it back again, to send out the upper Parts of the Plant. The strangest Circumstance is, that the rooting End should first shoot into the Air, and then turn down, to find a Place to fix on. This it is, which has kept the World so long in Ignorance about the growing of this Seed. For by requiring a new, smooth Part of the Bark whereon to fix the rooting Part, it has frustrated all Attempts of sowing it as we do other Seeds.

V. I. P. 256. In Strawberries and Raspberries the Hairs which grow on the ripe Fruit, are so many Tubes leading to the several Seeds. And therefore we may observe, that in the first Opening of the Flower, the whole inward Area is like a little Wood of these Hairs; and when they have received and conveyed their Globules, the Seeds swell and rise in a fleshy Pulp.

The Manner wherein *Mosses* in general Seed, is exceeding little understood. But in one Species at least, it may be clearly explained, from a Number of Observations. The Head of this *Moss* appears to the naked Eye, smooth and of a pale-brown Colour. The Top of this is bounded by an Orange-coloured Ring, which is a *Calyx*, containing sixteen pyramidal *Stamina*, loaded with a white *Farina*. These bend toward each other, and when the Head is nearly ripe, almost meet in a Point at their Tops. Immediately under the Arch formed by these *Stamina*, is placed a slender, hollow *Pistil*, through which the *Farina* makes its Way, and is dispersed among the Seeds in the Head. The external Membrane of the Head, is a Continuation of the outward Covering of the Stalk.

A Section of the Head shews, that this Membrane includes a Seed-vessel so large as to fill it every Way. This is filled with perfect and beautiful Seeds. They are round and transparent when unripe, but afterwards they are opaque, and of a beautiful Green. The Number of Seeds in one of these Heads, is not less than 13,800.

The *Seed Vessels* of *Mahogany Trees* are of a curious Form. They consist of a large Cone, which splitting into five Parts, discloses its winged Seeds. None would think, that so tall and so large Trees, could grow on solid Rocks. They are four Feet and upward in Diameter. The Manner of their Growth is as follows. The Seeds fly along the Surface of the Ground, and some falling into the Chinks of the Rocks, strike Root, then creep out upon the Surface, and seek another Chink. In this they swell to such a Size and Strength, that the Rock splits and makes Way for the Root to sink deeper. And with this little Nourishment the Tree in a few Years grows to that stupendous Size.

Other Trees have been propagated by a still more surprizing Way. One having caused some Ashen Pipes, that had brought Water to his Fountain twelve Years to be taken up, they were left in the Yard, where they rotted almost intirely. But in their Room there shot up a young Forrest of Ashes, which are now about four Feet high. There is no Ashe-tree within a great Distance of the Yard. Where then were the Seeds from which they sprung?

Mr. Bonnet of Geneva was inclined to try, whether Plants would grow, when planted in *Moss* instead of Earth. So he filled several Garden-pots with Moss, and compressed it more or less, as he judged the several Plants might require, a closer or a looser Soil.

He

He then sowed therein Wheat, Barley, Oats and Peas. And he found first, that all the Grains thus sown, came to Maturity later, than those of the same Sorts, which had been sown in Mould: 2. That the Stems from the Seeds sown in Moss, were generally taller than those sown in Earth: 3. That there came more Blades from the Grains sown in Moss, than from those sown in the Ground: 4. The Grains sown in Moss produced more plentifully than the others. 5. The Grains gathered from the Corn which grew in the Moss, having been sown again, partly in Moss and partly in Earth, succeeded well in both.

He also planted in Moss, Pinks, Daisies, Tulips, Junquills, and several other Sorts of Flowers. And all these succeeded full as well, as those of the same Sort which he planted in Mould. He also placed in Moss, Cuttings and Layers of Vines, all which grew up into Vines. And these in a while were larger than those which came from Cuttings and Layers planted at the same Time in the Ground.

The Husbandry of *Figs*, as it is still practised in many Parts, is one of the greatest Curiosities in Nature. There are two Sorts of Fig-trees, the Wild, and the Garden Fig-tree. The Wild bear three Kinds of Fruit, *Formites*, *Cratitires* and *Orni*: And all these are necessary to ripen the Garden-fig. The *Formites* appear in August, and hold to November without ripening. Herein breed small Worms, which turn to a Kind of Gnats, no where to be seen but about these Trees. In November these Gnats make a Puncture in the *Cratitires*, which do not appear till toward the End of September, and the *Formites* gradually fall off, after the Gnats have left them. The *Cratitires* remain on the Tree till May, and inclose the Eggs deposited in them. In May the *Orni* appear, which after they grow to a certain Size, are pricked by the Gnat issuing from the *Cratitires*.

None of these are good to eat, but only to ripen the Fruit of the Garden Fig-Tree in the following Manner. In June and July, the Peasants take the *Orni*, when their Gnats are just ready to break out, and carry them to the Garden Fig-tree. If they do not mind the Time exactly, the *Orni* drop, and the Garden-fruit not ripening, for want of its proper Puncture, will likewise fall soon after. Therefore they carefully inspect the *Orni* every Morning, and transfer such of them as are proper. By this Means the Garden-figs become ripe, in about six Weeks after they have received the Puncture of the Insect. When they have dried them in the Sun, they put them into Ovens, to destroy the Eggs of the Gnats laid in them, from whence otherwise Worms would be produced, which would consume the Fruit.

What an Expence of Time and Pains is here! Who can but admire the Patience of the Greeks, busied above two Months in carrying these Prickers from one Tree to another! But how do these contribute to the ripening of the Garden-figs? Perhaps by causing the nutritious Juice to extravasate, whose Vessels they tear asunder, in depositing their Eggs. Perhaps too they leave with their Eggs some Kind of Liquor, proper to ferment with the Milk of the Fig and make it tender. Figs in *Paris* ripen sooner for having their Buds pricked with a Straw dipt in Oil.





Of some particular Plants.

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| <ol style="list-style-type: none"> 1. <i>Grass of the Submarine Meadows :</i> 2. <i>Submarine sensitive Plant :</i> 3. <i>Odd Motion of Hop-vines :</i> 4. <i>Jamaica Pepper :</i> 5. <i>Peruvian Bark :</i> 6. <i>The Balsam-tree :</i> 7. <i>Manna :</i> 8. <i>Palm-trees :</i> | <ol style="list-style-type: none"> 9. <i>Manchineel-tree :</i> 10. <i>Indian Poison :</i> 11. <i>Sugar not unwholesome :</i> 12. <i>Maple-Sugar :</i> 13. <i>Malasses extracted from Apples :</i> 14. <i>The Fountain-tree :</i> 15. <i>The Quicksilver Plants :</i> 16. <i>Ambergris.</i> |
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P. 261. **T**HE *Grass of the Submarine Meadows* is not a Span long, and is of a green approaching to a Yellow. The *Tortoises* seem to live wholly on this; but they bite much more of it than they swallow. Hence the *Sea* is covered with this *Grass*, wherever they feed at the Bottom. About once in Half an Hour they come up, fetch one Breath like a Sigh, and sink again. They breathe somewhat sterner, when on Shore; if you hurt them, the Tears will trickle from their Eyes. They will live out of Water so Days and be fat, if they have twice a Day Half a Pint of Salt-water.

A *submarine Sensitive Plant* has been observed on the *Irish Coast*. It consists of a long slender Tube about as thick as the Barrel of a Goose-quill, growing about six or eight Inches, out of the Crevices of the Rocks, especially in such Hollows as the Salt-water remains in, after the Tide ebb away. In the Middle of the Tube springs up a slender Stalk. The Top of which is a reddish, round vesicle. If you

point a Finger to this, as soon as you are near touching it, the Stalk withdraws to the very Bottom of the Tube, and the Tube itself bends and becomes flaccid. The Plant has no Branches, nor can the Root be separated from the Rock without breaking it. On the *Cornish Shores*, there grows a Kind of *Sensitive Fucus*. Bring this so near the Fire as just to warm, and its Edges shrink up. In this State move a Finger toward them, and they shrink from, but if the Finger is removed, recover their former Situation. Placed on a warm Hand, it moves perpetually to and from the Hand, like an Animal struggling for Life. This odd Effect is entirely owing to the Structure of these Plants. They are so extremely thin, that they yield to the Perspiration of the Hand; the Effluvia being of Force sufficient to repel the Leaves when they are near.

P. 262 after *Vegetable Kind*.

The *Vines* of *Hops* wind about the Poles with the Sun, those of *Kidney Beans* against the Sun, and that so obstinately, that although the one or the other be over-night wound the opposite Way, yet in the Morning it will be found to be got back again to its natural Bent.

The Tree that bears *Jamaica Pepper* is about thirty Feet high, and covered with a grey, smooth, shining Bark. It shoots out Abundance of Branches, which bears large Leaves, like those of the Bay-Tree. At the very End of the Twigs grow Bunches of Flowers, each stalk bearing a Flower which bends back. To these succeeds a Bunch of Berries, larger when ripe than Juniper Berries. They are then black, smooth and shining; but they are taken from the Tree when unripe, and dried in the Sun. They have a mixt Flavour of many Kinds of Spice, and hence they are called *All-spice*.

P. 263. *Peruvian-Bark* comes from a Tree, about the Bigness of a Plum-tree. Its Leaves are like Ivy, and are always green. It is gathered in Autum, the Rind is taken off all round, both from the Boughs and the Tree, and grows again in four Months. It bears a Fruit not unlike a Chestnut, except its outward Shell. This Shell is properly called *China-China*, and is esteemed by the Natives, far above the Bark, which is taken from the Trunk or Boughs. And it seems this only was in Use, till the Demand for it so increased.

The *Balsam Tree* grows on Rocks, and frequently on the Limbs or Trunks of other Trees. This is occasioned by Birds, scattering or voiding the Seeds, which being glutinous like those of Mistleto, take Root and grow; but not finding sufficient Nourishment, the Roots spread on the Bark till they find a decayed Hole wherein is some Soil. Into this they enter and become a Tree. But the Nourishment of this second Spot being exhausted, one or two of the Roots pass out of the Hole, and fall directly to the Ground, though at forty Feet Distance. Here again they take Root, and become a much larger Tree than before. They flourish on the *Bahama Islands*, and many other of the hot Parts of *America*.

In Italy are many Coppice Woods, of what our Gardeners call the *flowering Ash*. *Manna* is procured by piercing the Bark, and catching the Sap, as we do that of Birch Trees, to make Birch Wine. It begins to run in the beginning of August, and in a dry Season, runs for five or six Weeks. But we have no need to be beholden to the King of Naples. For the Tree grows as well in *England* as in *Italy*. What Stupidity is it then, to import at a large Expense, what we may have at our own Doors?

Palm Trees are Male and Female. In March or April, when the Sheaths that inclose the young
I 3 Clusters

Clusters of the Flowers and Fruit begin to open, (at which Time the Dates are formed) they take a Sprig of the male Cluster, and insert it into the Sheath of the Female; or else take a whole Cluster of the male Tree, and sprinkle the Farina of it over several Clusters of the Female. Where they use the former Method, one Male suffices to impregnate 4 or 500 Females.

The Palm Tree is in its greatest Vigour about 30 Years after Transplantation, and for 70 Years longer bears yearly, 15 or 20 Clusters of Dates, each of 15 or 20 Pounds Weight. Afterward they gradually pine away, and usually fall about the latter End of their 2d Century.

To procure the Honey of the Palm Tree, they cut off its Head, and scoop the Top of the Trunk into the Shape of a Basin. The Sap ascending lodges in this Cavity, for the first ten or 12 Days, three Quarts or a Gallon a Day. Then it gradually diminishes, till in six or eight Weeks, the Juices are consumed and the Tree is fit only for Firewood. This Liquor is a thin Syrup, of a more lucious Sweetness than Honey. Hence our Poet mentions

"Fruit of Palm Tree pleasant to Thirst
And Hunger both." Though one would imagine, a Liquor of that Kind, would not be very proper to quench Thirst.

The *Manchineel* Apple is most beautiful to the Eye, agreeable to the Smell, and pleasant to the Taste, but if eaten it is certain Death. Yea, the whole Tree is so poisonous, that the Wood of it while Green, if rubbed against the Hand will raise Blisters. And if Rain falling from the Leaves light on the naked Skin it will have the same Effect.

The Wood is good for Tables, Cabinets, and all other curious Work. But the virulent Nature of the Sap, calls for great Caution in felling the Tree. I was cutting down one of them, says Mr. *Catsby*, when some of the milky Juice spouting in my Eyes,

I was

I was two Days totally blind, my Eyes and Face being much swelled. For four and twenty Hours, I felt a violent, pricking Pain, which then gradually abated. Indeed not only Rain or Dew falling from the Leaves, raise Blisters on the Skin, but even the Effluvia will affect the Senses of them that stand any Time under the Shade of it.

V. L. P. 264 after *Man's Head*.

Many Physicians affirm, That Sugar is unwholesome, and most, that it destroys the Teeth. But how will this agree with the following Account?

"My Grandfather, says Dr. Stare, took as much Sugar as his Butter spread upon Bread would receive, for his daily Breakfast. He put Sugar into all his Ale and Beer, and into all the Sauces he used to his Meat. At eighty Years old he had all his Teeth strong and firm, (having never had the Tooth-ach) and never refused the hardest Crust. In his 82d Year one of his Teeth came out, and in two or three Years all the Rest. But others filled up their Room, and in a short Time, he had a new Set quite round. His Hair also from very white became dark. He continued in Health and Strength, and died without any Disease, in his Ninety-ninth or hundred Year.

It is not only from the Canes that Sugar is extracted: In *New England* much of it is made from the Juice of the *Upland Maple*. They first make a Hole in the Tree, within a Foot of the Ground, shelving inward, so as to hold about a Pint. Then they tap this Hole, and by a Reed draw off the Liquor into a Vessel. A large Tree will yield between the Beginning of February and the End of April twenty Gallons of Juice. A Gallon in boiling 16 Hours is reduced to three Pints and yields more than two Pounds of Sugar, which our Physicians prefer to all other, for Medicinal Uses.

Molasses likewise may be procured without Sugar-canes. This was discovered a few Years ago, by Mr. Chandler

Chandler of Woodstock, in *New-England*, an inland Town, where the common *Molasses* is scarce and dear. Ever since both he and his Neighbours supply themselves with it, out of their own Orchards. The Apple that produce it, is a Summer Sweeting, of a middling Size and full of Juice. They grind and press the Apple, and then gently boil the Juice for about six Hours. In that Time it comes to the Sweetness and Consistency, and answers all the Purposes of other *Molasses*.

P. 265. An admirable Instance of Divine Providence we have in the *Fountain Tree*, which grows on *Hierro*, one of the *Canary Islands*. In the rocky Cliff which surrounds the Island, is a narrow Gutter, which begins at the Sea, and continues to the Summit of the Cliff, where it falls into a Valley, which is bounded by the steep Front of a Rock. On the Top of this grows a Tree, which has continued many Years. Its Leaves constantly distill as much Water, as is sufficient for the drink of every living Creature on the Island. It stands by itself, a League and a Half from the Sea, and no one knows of what Species it is. Its Trunk is about nine Feet round, in Diameter about Three. It is thirty Feet high; the Circumference of all the Branches together is about Ninety. The Branches are thick, the lowest of them is about an Ell from the Ground. Its Fruit resembles an Acorn, its Leaves resemble those of the Laurel, but are longer and broader. They come forth in perpetual Succession, so that the Tree is always green. On the Northside of it are two Cisterns of rough Stone, each fifteen Feet square, and twelve deep. One of which contains Water for the Drink of the Inhabitants; the other, for their Cattle and all other Purposes.

Every Morning, near this Part of the Island, a Mist rises from the Sea, which the South and Easterly Winds drive against the fore-mentioned Cliff, which it gradually ascends, and thence advances to the

the End of the Valley: Being stop't there by the Front of the Rock, it rests upon the Leaves and Branches of the Tree, whence it distills the Remainder of the Day.

But Trees yielding Water are not peculiar to the Island of *Hierro*. One of the same Kind grows on the Island of *St. Thomas*, in the Gulph of *Guinea*. And of the same Nature is that near the Mountains of *Vera Paz*, whereof we have the following Account in *Cockburn's Voyages*.

"In the Morning of the fourth Day, we came out on a large Plain, in the midst of which stood a Tree of an unusual Size. Its Trunk was above five Fathoms round; the Soil it grew on was very stony. And on the nicest Enquiry we could afterwards make, both of the *Spaniards* and the Natives, we could not learn, that any other such Tree had been known in all *New Spain*.

"Perceiving the Ground under it wet, we were surprized, knowing that according to the certain Course of the Season in that Latitude, there had no Rain fallen for six Months, and that it could not be owing to the Dew, for this the Sun entirely dried up, in a few Minutes after his rising. At last, to our great Amazement, as well as Joy, we perceived Water dropping from the End of every Leaf; after we had been labouring four Days through extreme Heat, and were almost expiring for Thirst, we could not but look on this, as Liquor sent from Heaven, to relieve us in our Extremity. We caught it in our Hands, and drank so plentifully, that we could scarce tell when to give over."

P. 266. In the Valley of *Lancy*, which runs between the Mountains of *Jurin*, grows a Plant like the *Doronicum*, near the Roots whereof is found pure Quicksilver, running in small Grains like Pearls. One would not imagine the Plant had any Influence on this, but for the following Experiment. Express the

the Juice: Expose it to the Air in a clear Night, and there will be found as much Mercury as there is lost of Juice.

P. 268. Some have maintained, that *Ambergris* was a Substance naturally bred in one Species of Whale; in a Bag three or four Feet long: But this Bag is in Truth, only the Bladder of the Whale and the supposed *Ambergris* is only a Calculus of the Bladder. The largest of these ever found in a Whale, weighed twenty-one Pounds. But Pieces of *Ambergris* have been found, which were six Feet long and weighed above an hundred and eighty Pounds.

It seems, 1. That *Ambergris*, like yellow Amber, comes out of the Earth into the Sea: 2. That it comes, not like *Naphttha*, but in a thicker, viscid and tenacious Consistence. 3. That in the first Formation thereof, a liquid Bitumen or *Naphttha* is mixt with it. 4. That large Pieces may be generated at the same Time; but usually a small one rises first, to which another soon adheres, and so more and more, forming irregular Figures, under which it is soft, so that various Substances stick to it; but it gradually hardens to the Consistence of Wax.

And as *Ambergris*, so divers other fossil Bodies are found in Strata: However one would not be positive, as to the Manner of its Generation. For who can explain in what Manner Amber is produced? Or how Metals, Semi-metals, precious Stones, and innumerable other Mineral Substances are generated? We know what they are, but how they are formed, we know not with any Degree of Certainty.

C H A P. III.

Of Metals, Minerals, and other Fossils.

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| 1. Of Gold : | 13. Of the Strata of the Earth : |
| 2. Of Silver : | 14. Of the Surface of the Earth : |
| 3. Of Platina : | 15. The Nature of Stone : |
| 4. Iron is in almost every Thing : | 16. Of Lough Neagh : |
| 5. The Budding of Silver : | 17. Of petrifying Springs : |
| 6. _____ of Alum-Stone : | 18. Of petrified Shells : |
| 7. _____ of Fern-Ashes : | 19. Of Copper Springs : |
| 8. _____ of Sal Ammoniac : | 20. The Nature of Spar : |
| 9. Hungarian Salt-mines : | 21. Of Turquoise Stones : |
| 10. Of Mines in General : | 22. Experiments on Load-stones : |
| 11. Of Mundic : | 23. Poles of them changed by Lightning : |
| 12. Of the Fissures in the Earth : | 24. Of Amber : |
| | 25. Of Linum Asbestum. |

V. II. P. 6. **G**OLD is either found in small Grains in the Sand of Rivers, (formerly in several of the Rivers of Europe) or is dug out of the Earth, in small Pieces of a tolerable Purity. Sometimes it is also found, like the Ore of other Metals, in a Mass of Earth, Stone or Sulphur. In this State it is of all Colours, red, white, blackish, making no Ostentation of its real Value.

P. 7. **S**ilver, like the Ore of all other Metals, is found in the Earth, under different Forms and Colours. But it usually affects somewhat of a pointed, regular Form like Chrystals. It is never found in Sand

Sand or Grains, as native Gold is. It is sometimes Ash-coloured, sometimes spotted with red and blue, sometimes of changeable Colours, many Times almost black.

Altho' the History of Fossils has been diligently cultivated, especially by the Moderns, yet it must be owned, that amidst the vast Variety of them, there is still Room for new Enquiries. No wonder therefore, that among the great Variety of Salts, Ores and other Concretes, new Mixtures should daily be discovered. But that among Bodies so simple as Metals, any should still remain unknown, will doubtless appear extraordinary.

Yet so it is: There has been discovered in *New Spain*, an original Metal between Gold and Silver. The *Spaniards* call it *Platina*, from the Resemblance in Colour which it bears to Silver. It is of an uniform Texture, bright and shining. It takes a fine polish, and does not tarnish or rust. It is very hard and compact, but extremely brittle, and quite unmalleable.

It is found, not in Ore, but in small Grains, yet not pure, but mixt with a shining black Sand. There are likewise usually mixt with it, a few shining Particles of a golden Colour.

When exposed by itself to the Fire, it is extremely hard to melt. It has been kept for two Hours in an Air-furnace, in a Heat that would melt cast Iron in fifteen Minutes, without being either melted or wasted. But when exposed to a proper Heat with Gold, Silver, Copper, Lead or Tin, it readily melts and incorporates with them. Having been kept in an Assay-furnace with Lead for three Hours, till all the Lead was wrought off, it was found remaining at the Bottom, without having suffered any Alteration or Diminution. A Piece of it was put into strong Aqua-fortis, and kept in a Sand heat for twelve Hours, yet when taken out, it was no way corroded, and was of the same Weight as when put in. It

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has been said to be heavier than Gold: But that is a Mistake. Its Specific Gravity is to that of Water, as 15 to 1. Yet an equal Mixture of Gold and Platina, was near as heavy as Gold itself, being to Water as 19 to 1. It appears then, that no known Body comes so near Gold in Fixedness and Solidity. If it could be made as ductile as Gold, it would not easily be distinguished from it.

It farther appears, from many Experiments, that Platina is likewise found in large hard Masses; that these Masses are with great Labour, reduced into small Grains, which are afterwards ground with Mercury to extract the Gold, and that it is not to be brought into Fusion by the greatest Degree of Fire procurable in the ordinary Furnaces, whether exposed to its Action in close Vessels, or in Contact with the Fuel. It entirely resists the vitriolic Acid, which dissolves or corrodes every other known metallic Body except Gold. Nay it resists the marine Fumes; and the Regal Cement, so called, from its being supposed to purify Gold from all heterogeneous metallic Matters. It also resists the Force of the vitriolic and nitrous Acids, though applied in such a Manner, as to be capable of perfectly dissolving all other known metallic Bodies. It follows from other Experiments, that Platina contains no Gold; for it cannot any more than the common metallic or other soluble Substances, prevent a small Portion of Gold mixt with it from being discoverable. It farther appears, that Platina, like Gold is not acted on by the simple Acids which is known to dissolve every metallic Body besides: That Aqua Regia, the Solvents of Gold, prove menstrua for Platina: And that consequently the common Methods for assaying or purifying Gold by Aqua Fortis, Aqua Regis, or the Regal Cement, can no longer be depended on: That it differs from Gold, in giving no Stain to the solid Parts of Animals, not striking a purple Colour with Tin, not being revived from its Solutions by inflammable Spirits, not being totally precipitable by alca-

line Salts; that in certain Circumstances it throws out Gold from its Solutions; that these Properties afford Means of distinguishing a small Portion of Gold mixt with a large one of Platina, or a small Portion of Platina with a large one of Gold; and that Platina contains no Gold excepting the few Particles distinguished by the Eye. That Platina is precipitated from its Solutions by the vitriolic Accid, and by the metallic Substances, which precipitate Gold, though scarce totally by any: And that its Precipitates resist Vitrification, and this perhaps in a more perfect Manner than precipitates of Gold itself. It is therefore a simple Metal, of a particular Kind, essentially distinct from all those hitherto known, though possessed of some Properties generally supposed peculiar to Gold. Many of its Characters have been already pointed out; others result from combining it with the several Metals, with each of which notwithstanding its resistance to the most intense Fires by itself, or with unmetallic Additions, it melts perfectly; occasioning remarkable Alterations in their Colours, Texture, and Hardness. It melts with equal its Weight of each of the Metals, with one more readily than with another. With some it becomes Fluid, in a moderate Fire; but a strong one is requisite for its perfect Solution. Compositions of Silver, Copper, Lead, with about one third their Weight of Platina, which had flowed thin enough to run freely in the Mould, and appeared to the Eye perfectly mixed, on being digested in Aqua-fortis till the Menstrum ceased to act, left several Grains of Platina in their original Form. Upon viewing these with a Microscope some appeared to suffer no Alteration; others exhibited an infinite Number of minute bright globular Protuberances, as if they had just begun to melt. Platina hardens and stiffens all Metals; one more than another, Lead the most. In a moderate Quantity it diminishes, and in a large one destroys, the toughness of all the malleable Metals, but communicates some Degree of this Quality to Cast Iron. Tin bears much the least, and

and Gold and Silver the greatest Quantity without the loss of their Malleability. A very small Portion of Platina scarce injures the Colour of Copper and Gold: A larger renders both pale. A far less Quantity has this Effect on Copper than on Gold. It debases and darkens in Proportion to its Quantity, the Colour of the white Metals; that of Silver much the least, and of Lead the most. It in good Measure preserves Iron and Copper from tarnishing; scarce alters Gold or Silver in this Respect; makes Tin tarnish soon, and lead exceeding quickly.

P. 7. Of all the Substances concurring to form the terrestrial Globe, *Iron* seems to have the greatest Share; as it not only abounds in most Kinds of Stone, but enters greatly into the Composition of Clay: This may be judged from the Similitude of Colour between Clay and dry Iron-Ore, from the easy Vitrification of Clay, from the Resemblance of vitrified Clay to Clinkers of Iron, from its deep red Colour after Calcination, and lastly, from its yielding pure Iron, by being burnt with Oil.

A Friend of mine shewed me an odd Experiment. In a Glass placed over a moderate Fire, there was a continual budding of *Silver*, in the Form of a Branch. When this was clipped off with Scissors, and a little crude Mercury added, in a small Time there arose another Branch of true Silver, which had sucked in and converted into Metallic Sprigs, a considerable Portion of the Quicksilver. The increment of new Silver Branches ceased not, as long as the Fire was continued and fresh Mercury supplied, for the due Nutriment of this mineral Vegetation. The Ingredients were only Aqua-fortis, Quicksilver, and a small Quantity of Silver, far less than you may reap in a small Time from these Silver Springs. Yet far more Expence is blown away in Smoke, than can be recovered from this silver Harvest.

Not much unlike this was an Experiment made by a Gentleman, who kept in a Cabinet some Pieces of *Fire-stone* from a Coal-pit, and some large Pieces of crude *Allum-stone*, such as it was taken out of the Rock. After a Time both these had shot out Tufts of long and slender Fibres; some of which were Half an Inch long, bended and curled like Hairs. And as often as these Tufts were wiped off, they sprouted out again.

But both of these fall short of what is related by a curious Naturalist. "Having extracted the Salts out of a Quantity of *Fern-ashes* after the common Method, most of the Water being evaporated, I had several Pounds of Salt, most of which being dried, I exposed the Rest to the Air. Having put it into a large Glass, I forgot it for five or six Weeks: Looking after it then, I was saluted with a pleasing Spectacle. The Lixivium had deposited a large Portion of Salt, out of which sprung at a small Distance from each other, about forty Branches, which exactly resembled Fern, putting out many Leaves on each Side, from one Stem. They were of different Sizes, but the Figures of all were precisely the same. And these artificial Vegetables, taking care not to shake them, I preserved for many Weeks."

And yet the following Account is stranger still. "I mixt equal Parts of *Sal Ammoniac* and *Pot-ashes*, which were put into a tall Glass Body, till plenty of volatile Salts sublimed. I expected no unusual Appearance from this, having often repeated the Operation. Being called out just as the Salt began to appear, how was I amazed at my return, to see in the Glass-head a Forest in perspective, so delineated, as scarce to be equalled by the greatest Masters. They were a Representation of Firs, Pines, and another Sort of Tree which I had never seen. But of this delightful Spectacle I was soon deprived, by the Sublimation of more Salts.

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“The next Day I related this to Sir Robert Murray. He told me, one Davison, an experienced Chymist at Paris, had frequently shewed him in a Glass a great Company of Firs and Pines, full as lively as any can be painted. But in a little Time they disappeared. He produced them again at Pleasure. But herein his Operation differed from mine: The Substance out of which he raised those Shapes, was of a more fixt Nature; that which afforded mine, was volatile to the highest Degree. Again, He could constantly and regularly produce those beautiful Representations: Whereas mine unexpectedly appeared; nor have I any Hope of seeing them again.

Sal Ammoniac is made of the Soot arising from the Dung of four-footed Animals, as Sheep, Oxen and Camels, so long as they feed only on green Vegetables. This Dung is collected in the four first Months of the Year, when all these feed on fresh Spring Grass. This in *Egypt* is a Kind of Trefoil or Clover. But when the Cattle are fed on Hay, and the Camels on bruised Date-Kernels, their Excrements are not fit for this Purpose.

Vol. II. P. 10. *Soowar* is a large Village in *Hungary*, peopled with Miners, Wood-cutters and Officers of Excise. Near this are large Salt-Works. In the Borders of *Transylvania*, there are Mountains of Salt, sufficient to furnish the whole World. When cut, it grows again in a short Time. It is black at first, but when pounded, extremely white. In most Stables they keep large Pieces of it, which the Cattle lick at Pleasure. There is in this Mine a Chappel, with an Altar, a Pulpit, a Sacristy, Chairs and Forms, all cut out of the solid Rock. In this they have Service once a Year, the Week after Epiphany. But what is most curious is, the Flowers of Salt. They grow out of the Rock like the Beard of a Goat, but much finer and whiter. They are extremely beautiful, and are the purest, the whitest, and the keenest Salt in the World.

Mines in General are Cavities, within the Earth, containing Substances of various Kinds. These the Miners term *Loads*: If *Metallick*, they are said to be *alive*; if not, to be *dead Loads*. In *Cornwall* and *Devonshire* the *Loads* always run from East to West. Mines seem to be, or to have been the Channels of Waters within the Earth, and have Branches opening into them in all Directions. Most Mines have Streams running through them; where they have not, probably the Water has changed its Course. The Springs in these Parts are always hard, abounding either with stony or sulphureo-saline Particles. These Particles are either of a vitriolic or an arsenical Nature. The first concretes into white Cubes, resembling Silver, the second into yellow ones resembling Gold. Both these are by the Miners termed *Mundic*.

Mundic is variously coloured on the outside with blue, green, purple, Gold, Silver, Brass, and Copper colours. But within it is either of the Colour of Silver, of Brass or Gold Colour or brown. The other Colours are no more than a thin Film or Sediment, which Water variously impregnated, deposits upon the Surface.

There are few Copper Loads, if any, but have this Semi-metal (which is a Kind of wild Mock-copper) attending upon them. Therefore, in searching for Copper, it is reckoned a great Encouragement to meet with *Mundic*. The *Mundic* does not intimately incorporate itself, with the Ore of Copper; for Copper in its mineral State being usually of a close Consistence, repels the *Mundic*, which is therefore easily separated from the Ore.

Cornish Waters are infected by *Mundic*, more or less, according to the Quantity which they pass through, and the Disposition of the *Mundic*, either to retain or to communicate the noxious Particles of which it consists. Arsenick, Sulphur, Vitriol, and Mercury are the Constituents of *Mundic*, yet these

these so pernicious Ingredients are so bridled and detained by their mutual Action and Re-action, and by mixing with other Minerals, that the Water is not poisonous; (generally speaking) even in the Mine where it proceeds directly from the Mundic.

The *Mundic* resembles Plants, Animals, Moldings, Carvings, and sundry more Varieties, too numerous to insert. Shall we attribute this to a plastic Power superintending the Congress of Fossils, and sporting itself with natural or preter-natural Representations? Or shall we rather say, that the great Power which contrived and made all Things, needing no Delegate, artfully throws the flexible liquid Materials of the Fossil Kingdom into various Figures, to draw the Attention of Mankind to his Works, and thence lead them, to the acknowledgment, and Adoration of an intelligent Being, inexhaustibly wise, good, and glorious? Doubtless these are the Works of that same Lover of Shape, Colour, and Uniformity that paints the Peacock's Train, that veins the Onyx, that streaks the Zebra: It is the same Hand whose Traces we may discover even among the meanest and most obscure Fossils. God loves Symmetry, Gracefulness, Elegance, and Variety, and distributes them for his Complacency as well as Glory, limits them not to Plants, and Animals, and open Day-light, but like a great Master, habitually imparts them to all his Works, tho' in the deepest Ocean, and in the most secret Parts of the Earth.

Although *Fissures* are the natural Result of a moistened and mixed Congeries of Matter, passing by Approximation of Parts into a State of Solidity, we are by no Means to conclude them useless, or the Works of Chance. No, the great Architect, who contrived the whole, determined the several Parts of his Scheme so to operate, as that one useful Effect should become the beneficial Cause of another. Hence it happens that Matter could not contract itself into solid large Masses, without leaving Fissures between them; and yet the Fissures are as necessary and

and useful as the Strata through which they pass.— These are the Drains which carry off the redundant Moisture from the Earth, which but for them, would be too full of Fens and Bogs for Animals to live, or Plants to thrive on.— Through these Fissures the Rain which sinks beneath the Channels of Rivers, not having the Advantage of that Conveyance above Ground, returns into the Sea, bringing the Salts and mineral Juices of the Earth into the Ocean, enabling it to supply the Firmament with proper and sufficient Moisture, and preserving that vast Body the Sea, wholesome, fit for Fish to live in, and Sailors to navigate.

In these Fissures the several Ingredients which form the richest Loads, by the continual Passing of Waters, and the Menstrua of Metals, are educed out of the adjacent Strata, collected, and conveniently lodged in a narrow Channel, much to the Advantage of those who search for and pursue them, for if Minerals were more dispersed, and scattered thinly in the Body of the Strata, the trouble of finding and getting at Metals (those necessary Instruments of Art and Commerce, and the Ornaments of Life) would be endless, and the Expence of procuring, would exceed the Value of the Acquisition:— Without these, neither Metals, Marbles, Salts, Earths, nor Stones, could be so easily, or in such Plenty, provided as is necessary for the Use of Man.

Earth is certainly the general Food and Stamen of all Bodies, yet we know of itself it can do nothing; it must be connected by a Cement, or it cannot form Stone; it must be softened and attenuated by Moisture and Warmth, or it cannot enter into the alimentary Vessels of Plants and Animals. The Parts of Earth which constitute the Solids of any Plants are exceeding fine, and the common Mass in which we plant Trees, is for the most Part Gravel, Clay, and Sand, which promote Vegetation, but are too gross to enter into, and become the constituent Parts of them. Water must therefore be considered as the Vehicle

of more solid Nourishment, and the Parent of the Fluids: The Earths, Salts, and Oils, are the great Instruments of the Increase of Solids. To trace Fertility a little farther: When the Earth is softened and diluted, heat rarefies and evaporates the Mixture, the Salts contained and dissolved, are always active and promote Motion; the Elasticity of the Air quickens and continues it; the Oils supple the Passages, of which some are fitted to secrete, arrest, and deposit the nutritious Particles as they pass; some adapted (by the same secret Hand, which conducts every Part of the Operation) to throw off the redundant Moisture by Perspiration: the earthly Mixture composes the hard and solid Parts, and the genial, little Atmosphere of every Plant gives Spirit, Colour, Odour, and Taste. Herbs and Fruits being thus fed and matured, make the Earth they contain better prepared to pass into the still more curious and highly organized Parts of Animals. It is easy to see that this is rather a Detail of the several Materials and well-known Instruments, conducing to Fertility, than the Cause. Fertility is owing to the Concert, Fitness and Agreement of all these, with some volatile active Principle, of which we know nothing at all. But whence that Agreement results, how the Materials ferment, replace, connect, and invigorate one another, how the Vessels chuse and refuse, (if I may so say) in order to produce the Fertility desired, is known only to the infinitely wise Disposer of all Things, ever attentive to the Nurture and Support of what he has created. But to whatever Cause the Fertility of Earth is to be assigned, Earth it must be owned is a most fruitful, universal Element. Animals, Plants, Metals, and Stones, arise out of it, and return to it again; there, as it were, to receive a new Existence, and form new Combinations, the Ruins and Dissolutions of one Sort affording more and more Materials for the Production of others.

In Stones and Metals, we admire the Continuity, Hardness and Lustre of Earth; in Plants the Rari-

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ry, Softness, Colours, and Odour; in Animals the Flesh, the Bone, and infinite Number of Fluids, in which this supple Element can take Place: But the greatest Wonder is, that Earth is capable of being subtilized to such an exquisite Degree, as by uniting and communicating with Spirit, to perform all animal Functions given it in change by the Soul. This is the highest and utmost Refinement; which in this State of Being, Earth is capable of; but that it may be still farther refined, in order to be qualified for a future, incorruptible, and more glorious State, is one of the greatest Truths which we owe to Revelation.

Wherever the Miners meet with Water, they do not want Air. When they find no Water, they are destitute of Air, sufficient to breathe in: But when they drive up an Adit, to draw away a great Quantity of Water, from a deep Mine; as soon as it is brought so near that the standing Water begins to run away, they must secure themselves as well as they can. For the Air included in the Water, breaks forth with such Violence as to carry all before it, loosening the very Rocks.

V. II. P. 11. The vegetable Mould or Surface of the Earth, is made up of Sands, Clays, Marls, Loams, rotten Stalks and Leaves of Herbs, serving both as a proper Bed and Covering, and as a Receptacle and Conductor of Moisture to the Roots of Trees and Plants. Sands and Pebbles may be considered as Drains, for carrying off the redundant Moisture, to Places where it may be ready to supply the Place of what is continually rising in Exhalations. But lest the Strata of Sand should be too thick, small ones of Clay are often placed between, to prevent the Moisture from departing too far, from where it may be of Use. And lest these thin Partitions of Clay, should let the Particles of Sand insinuate into them, and thereby let the Moisture pass through

thin Crusts of a ferrugineous Substance, are placed above and beneath each of these clayey Strata; by which Means the Clay and Sand are effectually kept asunder.

Supposing some Stones are organized Vegetables, and are produced from Seed, yet most Sorts of Stones, seem to be *unorganized Vegetables*. Other Vegetables grow by a *Solution* of Salts, attracted into their Vessels. Most Stones grow by an *Accretion* of Salts, which often shoot into regular Figures. This appears by the Formation of Chrystals upon the Alps. And that Stones are formed by the simple Accretion of Salts, appears from the Tartar on the Inside of a Claret Vessel, and still more clearly, from the Formation of a Stone in the Human Body. The Air is in many Places impregnated with such Salts or stony Particles. And these ascending from the Cavities of the Earth, may petrify Wood. In this Case the petrifying Quality is not originally, either in the Earth or the Water. But in the rising Sreams impregnated with with saline or stony Particles.

P. 12. With regard to *Lough Neagh*, the petrifying Quality, seems to be not only in the Water, but in the adjacent Soil. Many Pieces of petrified Wood are thrown up daily, in breaking up new Ground, which that Water never touched. They are often found two Miles from the Lough, in great Numbers, and deep in the Ground, altogether like the *Lough Neagh* Stones. That these were once Wood is certain. They burn clear, and may be cut with a Knife, tho' not so easily as other Wood.

P. 12. *Petrifying Springs* are impregnated, some with Particles of Stone, others with ferrugineous and vitriolic Particles. When the stony ones drop on Wood, or other Vegetables, they act mostly by Incrustation. They coagulate upon it, and by Degrees cover it with a stony Coat. If this be broke before the Wood is rotted away, you find it in the Heart of the Stone.

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If the Wood is rotted, you will find a Cavity in the Stone; but this also in Time will be filled up with stony Particles. Sometimes indeed these Waters permeate the Pores of the Wood, fill them up with their stony Particles, and by their burning Quality proceeding from Lime-stone, destroy the Wood, and assume the Shape of the Plant.

Metallic Particles mostly act, by insinuating into the Pores of Wood or other Vegetables, without increasing their Bulk, or altering their Texture, tho' it greatly increase their Weight. Such is the petrified Wood in and near *Lough Neagh*. It does not shew any outward Addition of Matter, and preserves the Grain of Wood. All the Alteration is in the Weight and Closeness, by the mineral Particles pervading and filling the Pores.

That there are Mines near the Lough, we may gather from the great Quantity of Iron-stones found on its Shores, and from the yellowish Ochre and Clay in many Places near it. Now whatever Springs run through these, will be impregnated with metallic Particles. And if they rise in the Middle of a River or Lake, and in their Course meet with Wood or other Vegetables, these Particles will insinuate and lodge themselves in their Pores, and by Degrees turn them into Stone.

That such Springs are under this Lake, appears from hence, that in the great Frost, 1740, though the Lake was froze over, so as to bear Men on Horseback, yet several circular Spots remained unfrozen. Hence it appears, that this petrific Quality is not in all Parts of the Lake, but here and there only. As to the Trees which are found petrified and buried at a small Distance from the Lake, probably it was broader once than it is now, so that what was then under Water, is now dry Land. If so, these Trees might have been petrified, in the Part which was then overflowed, though it is now dry.

But what shall we judge of those *petrified Shells*, which have been dug up in many Places? Some indeed

deed are not petrified. Near *Reading*, in *Berkshire*, for succeeding Generations, a continued Body of Oyster-shells has been found through the Circumference of five or six Acres of Ground. Beneath is a hard, rocky Chalk, on which the Shells lie in a Bed of green Sand, about two Feet thick. Above are various Strata for at least eighteen Feet. The Shells are so brittle, that in digging, one of the Valves will frequently drop from its Fellow. But several are dug out entire; nay some double Oysters, with all their Valves united.

In a Quarry at the East End of *Broughton* in *Lincolnshire*, there is a Clay under the Stone, in which are numberless Fragments of the Shells of Shell-fish of various Kinds. And there are sometimes found whole Shell-fish, with their Shells on, in their natural Colours, only bruised and broken, and some squeezed flat, by the Weight of Earth, which was cast upon them at the Deluge.

There is another Quarry, South of the Town, of a blue, hard Stone, (probably a pure Clay in some antediluvian Lake) in which are numberless Shell-fish of various Sorts, but so united to the Stone, that 'tis hard to get them out whole. They are all in the Surface of the Quarry, within a Foot of the Top. On the Surface, there are many Shell-fish half in the Stone, half out. That Part which is within the Quarry is whole, but is a hard Stone. That which is without, is all consumed, but a little of the Edges, which are plain Shell.

Some of the Shell-fish in this Quarry are half open, and filled with the Matter of the Bed on which they lie. Some of them are broken, others bruised: The Edges of one Fish is sometimes thrust into the Sides of another. One Shell of some is thrust half way over the other, and so they are petrified together.

Among these there are several great Horse-muscles, such as breed in Rivers and Ponds. And in the Fields and Stones near *Bramby* and *Frodingham* is found a Sort of Fish bending like a Ram's Horn, and creased

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like one on the outside. The Bed wherein, it seems, this Fish bred, is about a Foot thick: In which are Millions of the Fish, sticking half within the Stone, half without. And this Shell being extremely durable, even the Part sticking out, is not consumed, as it usually is in others, but remains whole and entire.

It is certain, that Water impregnated with metallic Particles, when falling on Wood or other Vegetables, will coagulate upon it, as was observed above, and cover it with a metallic Coat. It is also certain, that the Vegetables included therein, are gradually destroyed, till the same Matter which first formed the Crust, takes up the whole Space which they occupied before. But it is not only Wood and other Vegetables, which are capable of being thus acted upon, first crusted over and then destroyed. A Shovel of *Iron* some Years since lying in the Water, in the County of *Wicklow* in *Ireland*, was observed to be incruited with Copper, which gave Occasion to an important Discovery: A Gentleman, who visited the Place on Purpose, to examine the Truth of what was commonly reported, observes, "I saw the *Iron Bars* impregnating with Copper. I was an Eye-witness to the Change in all its Progress; and so were thousands besides. I saw the *Masons* laying a Chain of new *Stone Troughs*, for the *Copper Water* to run through. I saw the Men also laying the *Iron Bars*, on *Wooden Rrafters* in those *Troughs*. I saw the *Iron Bars* lifted up out of some *Troughs*, where they had laid from one to eight Months: And saw them incruited over with Copper, and corroded more or less, (some of them to very thin Plates) according to the Time they had lain in the Water. I saw some of the *Troughs* emptied, wherein the Bars were wholly dissolved: And the Labourers were throwing up with Shovels the Copper, which lay on the Stones in the Bottom of them. It was like Mud, as it lay wet in the Heap, but became Dust as it dried. I also

saw several Pieces of Copper, which had been made out of their Copper-Mud.

" This Water is supposed to flow over a Vein of Copper, in the neighbouring Mountain. It is of a sharp, acid Taste, and of a blue Colour. It is received and collected in those Troughs, wherein the Iron Bars are placed; which after lying in the Water, often not above three Months, are entirely consumed: Then at the Bottom of the Troughs, a Quantity of Copper is found, in the Form of coarse Sand. And it is remarkable, that there is a greater Quantity of this Copper, than there was of Iron.

" But by what Principle is this Effect produced?" In order to discover this, I made the following Experiments:

1. Some small Iron Nails put into the Water, were in four Minutes covered with a Substance of a Copper Colour. And during that Time the Nails gained four Grains in Weight. The Water had the very same Effect on Silver and Tin; but not on Gold. Hence we observe, the Colour and Increase of Weight were owing to the Adhesion of the Particles of the Matter dissolved in the Water by an Acid, which could not penetrate Gold.

2. " In order to determine the Quantity and Quality of this Matter, I put two Drams of small Iron Nails into three Ounces of the Water. After they had lain therein four and twenty Hours, I found the Surface of the Water covered with a thick Scum, exactly like that which usually covers a Chalybeate Spaw. I observed likewise, it had lost the blue Colour, and sharp, vitriolic Taste. It was quite transparent, and at the Bottom lay a brown Powder, which when dried, weighed fourteen Grains. This Powder, melted without any Flux, produced twelve Grains of pure Copper. The Nails also (which had lost eight Grains) were in several Places covered with a solid Laming of pure Copper. The Water being

afterward filtrated and evaporated, afforded a pure green Vitriol.

3. " From the Spring Water treated in the same Manner, I obtained a blue Vitriol, the Basis of which is Copper. From all these Experiments it appears, That a Mineral Acid is the active Principle in this Water, which being diffused through the Copper Ore, unites itself with that Metal, and forms a Vitriol. This is dissolved by the Water and remains suspended therein, till it meets with the Iron in the Trough, and by which it is more strongly attracted, than by the Copper. Therefore it quits the Copper, corrodes the Iron and changes it into a Vitriol, which is again dissolved and carried off in the Stream. Meantime the Copper, deserted by its Acid, falls by its specific Gravity to the Bottom of the Trough.

It appears then upon the whole, That this admirable Process of Nature, wherby one Metal seems to be turned into another, is no more than a simple Precipitation of the Copper, by Means of Iron.

V. II, P. 13. Dr. *Boerhaave* supposes Chrystal to be the Basis of all precious Stones. But Dr. *Borlase* ranges Chrystal itself and all Gems, under the Head of *Spar*, which says he, are only finer and purer Substances of the Spar-kind.

All Spar has been in a state of Fluidity. In some are found Straws and other light Bodies. Yet Time adds nothing to their Firmness; but they are as hard when first consolidated, as ever they will be. But why do we find no Spars in their fluid State? Because while the Matter of them remains incorporated with the Water, it is not to be distinguished from it, and as soon as it is deserted by the Water wherein it swims, it commences Stone. It is by Water that the sparry Atoms are washed out of their Repositories, and collected into a transparent or opaque Juice. As soon as the redundant Water is drained off or evaporated, the stony Parts accede to a closer Union. They are assisted therein, either by Cold, compressing the Parts,

or by sudden evaporating Heat. Thus the Stone is formed, so much Water resting in the Pores, as is necessary to fix it into a Consistency. Hence may arise some Queries.

1. Whether Spar is not the universal Gluten of Stones, distinguished from each other, by various Mixtures of earthy, mineral, or metallic Particles, but all united by the sparry Liquor? Perhaps there is scarce any Sand, Stone, or Ore, which either by the naked Eye or Glasses, may not be discerned to have a Portion of Spar, clearer or opaque, in its Composition.

2. Whether these and all other Sort of Stones are not continually forming in the Earth?

3. Whether there are not Quarries of Stone, which when left unwrought for a considerable Time, yield a fresh Supply of Stone, in those Channels, which had been before thoroughly cleared?

One Sort of precious Stones, as it has been long accounted, the *blue Turquois*, is indeed no other than fossil Bone, or Ivory saturated with Copper dissolved in an alkaine Menstrum; the *green Turquois* is the same Substance, intimately penetrated by a cupreous Matter dissolved in an Acid Menstrum.

P. 16. I cut a Piece, says Dr. Knight, of a Loadstone, into an oblong Square. In this I placed the magnetic Virtue in such a Manner, that the two opposite Ends were both South Poles, and the Middle, quite round, was a North Pole. I made the two opposite Ends of another Stone, North Poles, the opposite Sides South Poles. An irregular Stone had two broad, flat Surfaces opposite to each other. I made half of each of these Surfaces a North Pole, and the other half a South Pole. So that the North Pole of one Surface was opposite to the South Pole of the other. I took a Stone that had a Grain very apparent, running the Lengthways of it. At one End of it I placed a North Pole surrounded by a South: At the other a South surrounded by a North Pole:

So that the Edges of each Surface had a different Pole from that which occupied the Middle.

Many Varieties of this Kind might easily be devised. But these Examples are sufficient to shew, how manageable the magnetic Virtue is, with Respect to its Direction; and how defective all the Hypotheses are, which are brought to account for the Phenomena of the Loadstone.

An odd Discovery has been lately made, that not only Iron, as has been generally thought, but *Brass* too, by being hammered and properly touched, will construct a true magnetic Virtue. And perhaps it will be hereafter discovered, that other Metals may receive the same.

P. 16. Mr. *Howard* sailed to *Barbadoes* in Company with another Ship, commanded by one *Groston*. Suddenly a terrible Clap of Thunder broke *Groston's* Fore-mast, and did some Damage to his Rigging. When the Noise was past, he was surprized to see Mr. *Groston's* Ship steering directly homeward. He tacked and stood after him, and found that Mr. *Groston* did indeed steer by the Right Point of his Compass, but that the Card was turned round, the North and South Point having changed Places. If he set it right with his Finger, as soon as it was at Liberty, it returned to its former Posture. And on Examination, he found every Compass in the Ship had undergone the same Change.

Amber is a Kind of fossil Pitch, the Veins of which run chiefly at the Bottom of the Sea. It is hardened in tract of Time, and cast on Shore by the Motion of the Sea. It was long thought, that none could be found but in *Prussia*: But it has since been found in *Sweden*, on the Shores of the Isle of *Beorkoo*, though situate in a Lake, whose Water is sweet. Nay it is digged out of the Earth, at a considerable Distance from the Sea, and not only in sandy, but in firm Ground.

P. 18. Signior *Marco Antonio Castagna*, Superintendant on some Mines in *Italy*, has found in one of them a great Quantity of *Linum Asbestum*. He can prepare it, so as to make it like either a very white Skin, or a very white Paper. Both of these resist the most violent Fire. The Skin was covered with kindled Coals for some Time: Being taken out it was soon as white as before: Neither had it lost any Thing of its Weight. The Paper also was tried in the Fire, and without any Detriment. Neither could any Change be perceived, either with Regard to its Whiteness, Fineness, or Softness.



Part the Fourth.

Of Earth, Water, Fire, Air and Meteors.

CHAP I.

Of Earth and Water.

- | | |
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| 1. Sand probably, the general Cover of the Earth, | 18. The natural Origin of Bogs in Ireland, |
| 2. Different Species of Sand, | 19. Of Hatfield Chace, and the adjoining Levels, |
| 3. An Inundation of Sand, | 20. Of Newbury Peat, |
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| 16. Of subterraneous Trees, | |
| 17. Of the Great Level in Lincolnshire, &c. | |

P. 22. **I**T is probable, Sand was once the exterior Cover of the whole Earth. All our Northern

Northern Mountains are, more or less, covered with it at this Day. And the higher the Mountain, the coarser the Sand. The Rivers rising in the Mountains, still daily bring it down in large Quantities. And that it has been so in all Ages, since the first Rains fell on the Earth, seems highly probable, in that the Mouths of Rivers, and Entrances of Harbours are usually barred with it. And if you pierce deep into the low Ground near Rivers, you find this Mountain-Sand in great Quantities. It was the more fit to be the general Cover of the Earth, because of its great Hardness, and consequently durableness. Mountain Sand above all other, not being made (as much Sand is) by Attrition, steddily keeps its original Figures and Magnitude.

All Sands are either natural or fictitious. Natural Sands are those which have been in the same, or nearly the same State from the Creation, diffused through all Parts of the Earth. Sand viewed in a Microscope is no more than a Parcel of little Stones; doubtless therefore they must have begun to exist, and been formed by the same Laws that Stones were formed by. Now, Stones were formed first into hard and solid Masses, in Proportion to the Quantity of similar Materials, and proper Cement. Where there was a great Quantity of lapideous Particles, and few heterogeneous Mixtures, there Strata, Rocks, and large Stones were formed. But where the lapideous Particles were scattered and disunited by the Intervention of other Bodies, there small Rubble, Stones, Gravel, Grits, and the smallest and most numerous of all Stones, Sand, coalesced into minute Gleebs. This probably was the Process in every Part of the Earth; so that Sand is one of the primæval Bodies, concerted at the same Time with Stones, upon the highest Mountains, as well as in the Valleys; and at the Bottom of the Sea, as well as upon dry Land.

Besides this natural Sand, there is also a Fictitious one, which owes its Origin to the melting of River or Sea-water. For Water always in Motion, prays upon the

the Stones, and grinds them by Degrees into that stony Powder which we call Sand: Hence it is that the Sand of a particular Stone, Cove or Bay, has generally the same Colour, and in a Microscope the same Structure, as the Rocks, and Stones of the adjacent Cliff, and the Strata under the Sea, upon which the Waves are perpetually working, and driving into the Shore what they dash off from those Strata.

We have heard of large *Bodies of Sand* moving together in the Desarts of *Arabia*. But has any Thing of the Kind been known in *England*? There has, and that very lately. It is not a Century, says Mr. *Wright*, since our Sands, near *Dewnam* in *Suffolk*, first broke Prison. In a Warren near *Lakenheath*, an impetuous South West Wind having broken the Sand of some Sand-hills, the Sand blew upon the adjacent Grounds, which being much of the same Nature, the thin Crust of barren Earth was soon rotted and dissolved by this Sand lying upon it, and thereby fitted to bear it Company in its strange Progress. At its first Eruption, the whole Magazine of Sand could not cover above eight or ten Acres of Land. But it increased into a Thousand Acres, before the Sand had travelled four Miles. Above thirty Years since it reached the Bounds of this Town, where for ten or twelve Years it did no inconsiderable Mischief; because its Course was then down the Hill, which sheltered it from the Wind that gave it Motion. But the Valley once past, it went above a Mile (up-hill) in two Months Time. It over-run two Hundred Acres of good Corn that same Year. 'Tis now got into the Body of this little Town, where it has buried several Houses. And the Remainder have been preserved at more Expence than they were worth. At the other End of the Town divers Houses are buried, and our Pastures and Meadows destroyed. A Branch of the River *Ouse*, upon which we border for three Miles together, is more than half filled up with Sand. And had not this interposed to stop its Passage into

into *Norfolk*, doubtless a considerable Part of that County, had e'er now been left a desolate Trophy of this conquering Enemy.

As Air is necessary every Minute to give Spring and Motion to the Solids, as well as Fluids of all Bodies, so is *Water* to renew the Liquids which are perpetually shifting their Place, and without constant Supplies, would leave the Solids they depart from mere Dust. *Water* is therefore dispers'd throughout the Universe, in order to maintain the Coherence of all Bodies, supply Waste, and prevent the Ascendency of Fire, which without *Water* to oppose and qualify it, would parch and reduce all Bodies to a Calx, to Ashes or Cinders.

Particles of *Water* are generally allowed to be round. This Figure indeed is not to be demonstrated, but is inferred from its Fluidity. Allowing then the Particles of it to be round, Fluidity must be an essential Property of all Quantities and Assemblages of it. For take any Mass of round Bodies, (Bullets for Instance, Pebbles, or the like) they will not cohere or rest by one another without Force, but will flow on every Side, till they meet with such Resistance from external Bodies, or their internal Gravitation, as shall prevent farther Motion.

The Particles of *Water* are unalterable, for passing into so many Bodies, and through such alternate Extremes of Heat and Cold, if they had not preserved their essential Properties constantly, Moisture since the beginning of the World, must have very sensibly diminished. But seeing that no such Deficiency appears, and that Springs, Rains, and Rivers, are as abundant now as they antiently were (as by the rising of the Nile for many Ages, among other Reasons, may appear) we are to conclude, though Waters may be transplanted, they can neither be transmuted nor destroyed. And wherever removed, they will make their Appearance again when at Liberty, in the same liquid State as they were before.

The

The Particles of Water are exceedingly small, for they may be so divided from each other, that one square Inch of common Water shall when rarified, fill a Space of 14000 square Inches. And it is computed that at least 1000 Particles of Water may be held on the Point of a Needle. By this it appears, that what we call Water is an Assemblage of small transparent Globules, which are composed again of an infinite Number of smaller Particles or Atoms of this elementary Liquor.

P. 24. The Rivers of *Indus* and *Ganges*, before they enter the Ocean, contain between them a large Peninsula, divided in the Middle by a Ridge of high Hills, which runs from East to West, quite to Cape *Coromarin*. On the one Side is *Malabar*, on the other *Coromandel*. On the *Malabar* Side it is Summer from September till April; a clear Sky and scarce any Rain. This is Winter on the *Coromandel* Side, every Day and Night yielding Abundance of Rain. So that as you cross the Hills to *St. Thomas*, in little more than twenty Leagues, you ascend the Hill with fair Summer Weather, and descend with a stormy Winter.

There is a like Ridge of Hills in *Jamaica* running from East to West, thro' the Midst of the Island. On the Southside of these there is Summer from November to April, on the Northside, Winter, and so vice versa.

Hence it appears, that not the lessening the Gravity of the Atmosphere only, is needful to produce Rain, but likewise either a Change of Winds, or a Ridge of Hills, to drive the Particles of the Vapours together. And hence it is, that while the Wind blows from North East in *Coromandel* and on the North-side of the Mountains in *Jamaica*, there are continual Rains, and constant fair Weather on the South-side of the Mountains and in *Malabar*. Whereas while it blows from the South West, there are constant Rains on the Southside of the *Jamaica* Mountains and in *Malabar*; but constant fair Weather

ther on the North-side of those Mountains and in *Coremondel*.

This also may account for the Singularity of Seasons in *Peru*, which runs Southward from the Line above a Thousand Leagues. It is divided into three Parts, long and narrow: The *Lano's* or Plains, which run along the Sea-coasts, the *Sierra's*, which are Hills with Vallies intermixt, and the *Andes*, which are steep and craggy Mountains. The *Lano's* are, some ten Leagues in Breadth, some less, and some more. The *Sierra* is 20 Leagues in Breadth, and the *Andes* the same. It is remarkable, 1. that in the *Lanos*, the South and South West Winds continually blow. 2. That they never have any Thunder, Hail, Snow or Rain, only sometimes a small Dew. 3. On the *Andes* it rains almost continually. 4. In the *Sierra*, which lies between, it rains from September to April, and is clear from April to September. The Reason is plain; the constant Wind blowing over the *Lanos*, finds nothing to stop it and drive the Vapours into Rain. But the *Andes* continually intercept these Vapours, and so occasion continual Rain. The *Sierras* being lower, intercept the Vapours, only from September to April, because then the Sun being nearer, the Atmosphere is lighter, and consequently the Vapours sink lower.

P. 25. The Height of *Snowden Hill*, supposed the highest in *Great Britain*, is 1240 Yards. The Height of several Mountains in *France* is as follows:

	Feet
<i>Bugarach</i> in <i>Languedoc</i>	2988
<i>Le Puy de domme</i> in <i>Auvergne</i>	4860
<i>Le Courland</i>	5088
<i>Le Coote</i>	5106
<i>Le Cantal</i>	5904
<i>Le Mont d'or</i>	6180
<i>Le Mont Ventoux</i> in <i>Avignon</i>	6216
The Height of the <i>Pyrenean Mountains</i> is,	
<i>St. Barthelemi</i>	7110
M	L ₂

La Montagne des Mauffet 7548
Le Conigoe 8640

Probably these Mountains may vie in Height with most in the known World. Yet above all these is the *Stella Piz Hail*, a steep Mountain in the *Grisons*, which is 9585 *Paris Feet* above the Level of the Sea; an Height which the Wild-goats themselves scarce venture to ascend.

But Mr. *Martel* informs us, that the highest Point of *Mont Blanc* is higher even than this: That it is 1076 Toises above the Level of the *Rhone*, which added to the Height of this above the Sea, makes 13115 *Paris Feet*, or above two English Miles, and two Thirds of a Mile. If so, this is the highest Mountain in *Europe*, and perhaps in all the World.

"But is not the celebrated Mount *Atlas* in *Africa*, the Wonder of all Ages, far higher than this?" One who saw it, and travelled all over it, is best able to answer this Question. He wrote thus,

Barbary is bounded on the South by *Biledulgerid*, from which it is divided by *Atlas*, a Chain of Mountains, but not of that extraordinary Height or Bigness, which the Antients attributed to it. Those Parts of them, says Dr. *Shaw*, which I have seen, are rarely, if ever equal to some of the Mountains of our own Island, and cannot any where stand in competition, with either the *Alps* or *Appennines*. *Atlas* is a Number of Hills, usually 4, 5 or 600 Yards high, with an easy Ascent, and Groves of Fruit and Forest-Trees, rising up, one behind another. Only here and there is seen a rocky Precipice, of a superior Eminence.

The Benefit of Mountains in general is not only, that Vapours driven against them are condensed, so as to be precipitated through the Chinks of the Rocks, but that afterwards in their Bowels they are preserv'd, till they form Rivulets and then Rivers. Vapours would fall in Rain or Dew, tho' there were no Mountains, but then they would fall equally, over considerable Places of the Globe at once, and so would

would be suck'd deep in the Ground, or make an universal Puddle; whereas by Means of Mountains, they are perpetually pouring down in particular Places, and treasuring up for a constant supply to the Rivers. Another considerable Use of them, is the Determination of these Rivers: for if there could have been Rivers without Mountains, yet they could only have run in a straight Line, if they had run at all; whereas by these Eminences, placed up and down, they make innumerable Turnings and Windings, whereby they enrich, fatten, and water the Soil of several different Countries in one Course, and at last disembogue in several Mouths into the Sea.

Lastly, most Hills are the Nests of Metals or Minerals, either of Stone, Iron, Tin, Copper, or such like lower Vegetables. These Metals and Minerals by the Efficacy of subterranean Heat, converting the adjacent Earths into their Substance, encrease and grow as truly as Animals or Vegetables. I just mention their Use for the Production, Shelter, and Nourishment of some Sorts of Vegetables and Animals, which could not grow or live so well any where else. But from the whole, we may see of what Advantage these unlighty Moles (as some thought them) are to the Accommodations and even Necessities of Life.

P. 28. The Nile, which the Natives call *Athana*, that is the Father of Rivers, rises first in *Sacra*, a Province of the Kingdom of *Conana*, the most fruitful in all *Abyssinia*. In the Eastern Part of this Province, on the Declivity of a Mountain, are two Springs, each about two Feet Diameter, a Stone's Cast distant from each other, which are the real Source of this celebrated River. Its Waters, after the first Rise, run East about a Musket-Shot, then turning to the North, continue hid in the Grass and Weeds, for about a Quarter of a League, and discover themselves for the first Time among some Rocks, a pleas-

ing fights to those who have read the fabulous Accounts of the Antients. It flows thence with a very small Stream, but soon receives such an Increase from various Rivulets, that not above three Days Journey from its Source, it is near a Mile broad. After running nine or ten Leagues farther, it enters the Lake of *Dambia*. It crosses this at one End, with such Rapidity, that the Waters of the Nile may be distinguished thro' the whole Passage, which is six Leagues. Fifteen Miles farther it rushes from the Top of an high Rock, and forms one of the most beautiful Cascades in the World. The Fall of this mighty Stream from so vast a Height; makes a considerable Noise. Yet the neighbouring Inhabitants are not deaf, but hear just as well as others. After this Cataract, the Nile again collects its scattered Streams, and flows on thro' various Nations. Hence we may learn, that it is impossible to arrive at the Source of the Nile, by tracing its Channel from the Mouth, there being so many Cataracts in the Way, which no Vessel can pass.

In *Abyssinia* from June to September, there is no Day without Rain. Now the Nile receives, in its Course all the Brooks, Rivers and Torrents, which flow from the *Abyssinian* Mountains. These necessarily swell it above the Banks, and fill the Plain of *Egypt* with the Inundation. This comes regularly in the Month of July, that is, three Weeks after the Beginning of the Rains in *Ethiopia*.

There is very little Difference between the Bottom of the *Red Sea*, and the Surface of the neighbouring Countries. There are at the Bottom of the Water, Mountains, Plains, Valleys, and Caverns, just as upon the Land. The Soil consists of different Strata planted one upon another; and for the most Part, corresponds to those of the Rock, Islands, and neighbouring Continents. They contain Stones of different Sorts, Minerals, Metals, various petrified Bodies

Bodies, Pumice-stones and Lavas, formed by Vulcanos. *Istria, Dalmatia, Albania*, and other adjacent Countries, as well as the Rocks, the Islands, and the Bottom of the *Adriatic Sea*, consist of a Mass of white Marble, of an uniform Grain, and of almost of an equal Hardness. This vast Bed of Marble in many Places under both the Earth and the Sea, is interrupted by several other Kinds of Marble, and covered by a great Variety of Bodies. The Variety of these Soils under the Sea is remarkable: It is to this are owing the Varieties of Plants and Animals found at the Bottom of the Sea. Some Places are inhabited by a great Number of different Species of Plants and Animals, in others, only some particular Species are found, and in others neither Plants nor Animals. These Observations not only point out to us the Resemblance between the Surface of the Earth and the Bottom of the Sea, but likewise one Cause of the Varieties, which are observed in the Distribution of the Marine Fossils found in the Earth.

In that vast Mass of Marble, which is common to the Bottom of the *Adriatic*, and the neighbouring Provinces towards the East, are a Multitude of Marine Bodies petrified; some of which are so united to the stony Substance, that they are scarce to be distinguished. Likewise a Crust is discovered under the Water in divers Places, and for a great Extent, which is a Composition of crustaceous and testaceous Bodies and Beds of Polypes of different Kinds, confusedly blended with Earth, Sand, and Gravel.

These different Bodies, which enter into the Composition of this Crust, are at the Depth of a Foot or more, entirely petrified and reduced into Marble. At less than the Depth of a Foot they approach nearer to their natural State. And at the Surface of this Crust, they are either dead, tho' extremely well preserved, or still living.

This demonstrates that Stones may be formed, from Things petrified, and actually are formed, in

great Quantities under the Water. Crustaceous, and testaceous Bodies and Polypes, are every where mingled in the utmost Confusion, which shews a striking Resemblance between the Crust discovered under the Sea, and the marine Bodies petrified in many Parts under the Earth.

The more these crustaceous and testaceous Bodies and Beds of Polypes multiply, the more their Exuviae, and Skeletons contribute to enlarge this Crust. In several Parts it forms very considerable Banks, and of a very great Thickness.

It follows, that the Bottom of the Sea is rising constantly higher and higher. Divers other Causes contribute to this Snow and Rain. Waters bring down from the Mountains, into the Sea, a great Quantity of Earth and Stones. The Waves, beating against the Continent and Islands, detach many Masses, which are spread upon the Bottom of the Sea. The Rivers carry the Mud with their Waters into the Sea, at the Bottom of which that Mud deposits itself.

From the rising of the Bottom of the Sea, that of the Level of the Water naturally follows. So at *Venice*, in *Istria*, and in *Dalmatia*, the Level of the Waters is several Feet higher than it was formerly. This Elevation is observed only on the northern and eastern Coasts of the *Adriatic*. The Sea seems on the contrary, to abandon the western Coast, that of *Italy*.

Ocean-shells are frequently found very near the Surface, which proves that such Places formerly have been the Sea-shore. Hence it is clear, that the Cause which transported them thither, acted suddenly; which perfectly agrees with the Account of the Deluge given by *Moses*.

The greatest Depths of the Sea, as yet sounded, have been found to be about 3000 Fathoms. The ordinary Depths are about 150. Though these Shells are to be found in almost all the plain Parts of the Surface of the Earth, yet there are certain very large Tracts,

Tracts, where such Bodies are never found, viz. the Mountains, which seem to be the Remains of the original Strata of the Earth. It is true that there are many Eminences, which have been taken for Mountains, where Sea-shells of every Kind are found; but these are Hillocks, compared with the large Mountains, which may be traced in immense Chains, without almost any Discontinuity, from one Continent to another; and from Continents to neighbouring and opposite Islands, insomuch that all these Chains, not only of the old, but likewise of the new World, seem connected one with another. In the *Alps*, *Apennine* and *Pyreneans*, no Shells nor marine Bodies of any Kind are to be found; neither in the large *Grampian Mountains* in *Scotland*.

The same is observed of all the large Mountains of *Africa*, and of *Asia*, and in the huge Chain of *Cordilleras* in *Peru*. This Kind of Mountains (which indeed alone deserve that Name) are chiefly composed of vitrifiable Matter; and if they are sometimes found to contain Sea-shells, it is never to great Depths, though such Bodies are found in great Abundance at the Foot of Mountains, and in the adjacent Valleys, in which there are many Eminences, though but of small Extent, which contain Marble, Sea-shells and Chalk, but never any Veins of Metal.

The Deluge must have produced very considerable Changes on the Surface of the Earth. Many Volcanos were formed at that Time by the Accumulation of animal, vegetable and mineral Substances, in huge Masses which afterwards fermented and putrified, and in Process of Time burst out into Flames. Earthquakes must have been frequent in the first Years after the Deluge, by the Fermentation of these heterogeneous Bodies, before the Remains of so prodigious an Inundation could be dissipated; for wherever there is any intestine Commotion in the Earth, its Violence must be greatly increased, if it meets

meets, with Water, and by its Heat reduces it into Vapour, which we know acts with an immense Force. There are many Observations, which prove that the Earth, or at least many Parts of its Surface, have suffered by Fire, not to mention the Marks of it, which are to be observed on many mineral Substances. The artificial Production of Potters Earth or Clay, is a very strong Argument in Support of this Opinion.

Potters Earth, as is well known, is found plentifully in most low Grounds and Valleys, between mountainous Tracts. By exposing common Flint Stones to the confined Vapour of boiling Water, a Clay of the very same Kind may be formed, and is no more than a Decomposition of the Flints. Hence it would appear, that wherever this Clay is to be found, there the Earth has undergone some Violence by Fire; and that this has been effected by Earthquakes, soon after the Deluge, seems extremely probable. The Deluge has given Origin to many fossil Substances, and given Combinations, which otherwise would not have happened. Chalk is no more than the Ruins of Sea-shells, and Lime-stones consist of the same Bodies cemented together by a stony Juice.

Amber appears to be, the Resin of antediluvian Trees (which are frequently found with it at this Day) united to the acid of Sea-salt, which abounds in the Earth. The Reason of Insects, Straws, &c. being immersed in Amber is now no more a Secret; for we know that nothing is more common than to find such Bodies immersed in the Resin of Trees. Fossil Sea-salt seems to have been deposited in the Quarries, from whence it is dug, at the Time of the Deluge. All or most Part of Pit-coal, appears to be of diluvian Origin, for it gives a Caput Mortuum, the Texture of which exactly resembles that of burnt Wood. We may reasonably suppose large Forests to have

have been buried at the Time of the Deluge, which have undergone a Fermentation and Putrefaction in the Earth, so that the Colour of the woody Part has been changed, though the Texture has remained in fire. All Bitumens, Pissalphaltum, &c. seem to be no more than Productions of resinous Substances united with mineral Acids, which have caught Fire in the Earth by fermenting with heterogeneous Matter, and have there undergone a Sort of natural Distillation and Exalation.

These are even demonstrated by Experiments; for Amber can be produced artificially, as likewise Bitumens by the Distillation of resinous Substances with mineral Acids.

V. II. P. 28. The River *Oby*, in *Siberia*, after running a Course of near 800 Leagues, falls into the *Mare Glaciale*. The Lake *Baikal* is the greatest fresh Water Lake yet discovered. It extends in Length above five Hundred Leagues, and is from twenty-five to 80 Leagues in Breadth. It is every where deep and navigable. The Water is extremely clear, and abounds with fine Fish. It receives abundance of Rivers, but none runs out of it, besides one, the *Angara*.

Salt Lakes are common in many Parts of *Siberia*. Some contain a pure, white Salt, fit for Use, which in Summer is chrysalized by the Heat of the Sun, and forms a Crust on the Top of the Lake. Springs of Salt-water sometimes rise in the midst of fresh Water. One of these rises through a Rock, in the Bed of the River *Angara*. Thirty Leagues above this, there is a Hill 30 Fathom high and 500 long, consisting entirely of Rock-salt. There are some Lakes, which were fresh some Years since, but are now salt. Some have by Degrees dried up; others appear, where formerly it was dry Ground. And some of these, which at first had no Fish, are now plentifully stocked therewith. The Natives say, Ducks and other Birds
 of various species frequent the Lakes in winter.
 Wood

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Birds that live upon Fish, carry their Eggs from one Lake to another.

P. 29. It is a curious Remark, which Dr. Cheyne makes, concerning *Fluids* in general. "I take Notice, first of the *Fewness* of the original *Fluids*, in Respect of the vast Number of compound Ones. The primary Ones hitherto known are only four, Air, Water, Mercury, and Light, three of which are seldom much compounded with others; so that it is Water alone, that is the Basis of all our Mixtures. It is the Parts of solid Bodies floating in this Fluid, that produce all our delightful and useful Varieties of Liquors: so frugal is Nature in Principles, and so fruitful in Effects and Compositions. Take Notice, 2dly. Of the great Difference between the *specific Gravities* of our Fluids, Mercury being eight Thousand Times heavier than Air. Now, not to mention the many Uses of this last Fluid in Artificers Works, had Air been as heavy as Mercury it had been altogether useless in Respiration; it had choked us immediately. And had there not been a Fluid of the same Weight with Mercury, i. e. a Collection of exceeding small, heavy *Spherules* in the present Circumstances of Mankind, I do not know what a great Part of the World would have done. For the Wickedness of Mankind, has brought many Diseases to that Degree of Malignity, that a thorough Cure could scarce be made of them without this Fluid. But by the Gravity of this, a Remedy is provided for all these Maladies, which are more than two or three. But that which is most wonderful in these Fluids is, 3dly. That universal Property, the Direction of their Pressure upon the Sides of the containing Vessel. In all Fluids of whatsoever Kind or Nature, this Pressure is communicated in Lines perpendicular to the Sides of the containing Vessel. And indeed this Property of Fluids, which is so uniform, is the necessary Consequence of the Sphericity of their constituent Particles.

Now

Now, could any Thing but the Almighty Power of God, have rounded those infinite Numbers of small Particles? Or could any Thing but his Wisdom have assigned them their true Dimensions, their exact Weights and required Solidities? We shall allow him to continue in his Infidelity, who can demonstrate by what Laws of Mechanism, all the Particles of Water were turned of the same Diameter, Solidity and Weight; and those of Air, Mercury and Light, turned all of different Diameters, Solidities, and Weights from one another; but all of the same Diameters, Solidities and Weights among themselves. And what a beautiful Idea of this Fluid does Sir *Isaac Newton*'s later Discoveries present us with; every Ray is endowed with its own Colour, and its different Degree of Refrangibility and Reflexibility. One Ray is Violet, another Indigo, a third blue, a fourth green, a fifth yellow, a sixth orange, and the last red. And these are the primary and original Colours from the Mixture whereof, all the intermediate ones proceed, and white from an equal Mixture of the whole; black on the contrary, from the small Quantity of any of them being reflected; or all of them in a great Measure suffocated. So that it is not properly Bodies that are coloured, but the Light that falls upon them; and their Colours arise from their Aptitude, to reflect Rays of one Colour, and transmit all those of another. The prominent little Parts, upon their Surfaces, according to their different Degree of Density and Thinness, are apt to reflect back upon our Organs Rays of one Colour, and of one Degree of Refrangibility and Reflexibility, and to let others pass through their Pores, and this one Colour too is less or more intense, according as their prominent Parts are of different Densities. For the first Degrees of Intenseness, in all the Primary Colours, seem to arise from the Degrees of Density and Thinness, and the subsequent Degrees, from the other different Degrees of Thickness, or Thinness of the Prominent little Parts of the Surfaces of Bodies. Light
acts

acts upon Bodies by heating, dissolving, and putting their Parts in a vibrating Motion. Bodies act upon Light, in drawing its Parts to them, and that in Lines perpendicular to their Surfaces. And as there may be different Degrees of Attraction in Bodies, which produce their different Degrees of Elasticity and Cohesion, so there must be different Degrees of Attraction in Mediums supposed, to account for their different Powers, in bringing the refracted Rays nearer to, or farther from the Perpendicular. For it is well known all Mediums have not the same refractive Virtue. Now, what a beautiful uniform, and simple Theory of Light is here! This is so very like the frugal Simplicity, and yet the manifold Variety of Nature, that one would be almost tempted to believe it true, were there no Experiment to confirm it. We may observe one more Instance of the wonderful Wisdom of Nature, in the Propagation of Light, viz. That a Ray of Light in passing from a luminous Point, through two differently refracting Mediums, to illuminate a given Point, spends the least Time (the refracting Powers of the several Mediums considered) possible; and consequently when a Ray passes through one Medium, from a luminous Point to reflect upon a given Point, it takes the shortest Way possible. This the Geometers have demonstrated. Now, is not this an Instance of Counsel and Design? Is not this like the Methods of Wisdom which will not spend more Time on a Thing than just what is necessary to do the Business; which will not go about, but take the shortest Course possible that will bring it to the Place designed?

P. 30. It seems peculiar to the Water of the *Thames*, that in eight Months Time it acquires a spirituous Quality, so as to burn like Spirits of Wine. Even when it stinks, it is not unwholesome: Men who were obliged to hold their Noses, yet drank it all the Way to the East-Indies, and found no Inconvenience. If you take out the Bung from any Cask that stinks,
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and let the Air come in, it will be sweet in 24 Hours. If you take a Broom-stick, and stir it well, it will be sweet in four or five Hours. It casts a black Lee to the Bottom, which remixing with it, causes a third or fourth Fermentation, after which it stinks no more. But though *Thames Water* does not putrify when it stinks, most other Water does, and is at that Time very dangerous to drink.

P. 33. On the fourteenth of December, 1759, there was at *Petersburgh*, the most excessive cold Weather that ever was known, even to 205 Degrees of *De Lisle's Thermometer*. At that Time Professor *Braun* repeated *Fahrenheit's* Experiments, in order to produce excessive Cold by Means of Spirit of Nitro combined with Snow. He saw with Surprise, the Quicksilver in the other Thermometer descend even to 470 Degrees: There the Quicksilver remained fixed in the open Air, for the Space of a Quarter of an Hour, and did not begin to rise till it was carried into a warm Room. He repeated the same Experiment, first with the same, and then with another Thermometer, with the same Success. But as Mr. *Braun* had not broken the Glasses, he could only at that Time form a Conjecture. On the 17th he produced, again, cold equal to that of the 14th, and communicated his Discovery at a Meeting of the Academy. On the 25th of December, in the Morning, between nine and ten, *De Lisle's Thermometer* was at the 190th Degree of Cold, and Mr. *Braun*, as well as Professor *Epinus*, repeated this Experiment. As soon as the former observed the Quicksilver immovable in the Thermometer, he broke the Glass, and found the Quicksilver frozen but not entirely; Mr. *Epinus's* Thermometer fell with extreme Rapidity, almost to the 500th Degree, and in breaking the Glass from below, he found the Quicksilver contained in it absolutely frozen. Both the Gentlemen found, that the Quicksilver, thus rendered solid, bore hammering and Extension, like other Metals;

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but being exposed to the open Air, it recovered its former Fluidity in a little Time.

Mr. *Epinus* went farther, to examine the Quicksilver when it was made solid. He poured Quicksilver into a Glass Tube, as thick as one's Finger, closed at the Bottom, but open at Top.

The Quicksilver in this Cylinder, which was about one Inch and half Long, froze in three Quarters of a Minute; and became solid, perfectly resembling other Metals. Mean Time it continually contracted, and its Surface, which was at first pretty high, soon sunk very low, and the Cylinder of frozen Quicksilver sunk to the Bottom of the fluid Quicksilver. We know the Contrary happens to water frozen and other Fluids, which extend as they become solid, and their Ice swims in the fluid Matter, of which they were produced. On the 26th of December, in the Morning, between nine and ten, the Cold became extremely sharp at 24 Degrees, and such as exceeded the greatest Degree of artificial Cold fixed by *Fahrenheit*. Mr. *Braun* repeated this Experiment with the same Success as the Day before. Counsellor *Lomonossow* made the same Experiment; and by Means of *Aqua-fortis*, the Cold came to 495 Degrees. He then poured in Spirit of common Salt, and the Quicksilver fell in the Thermometer to 554 Degrees; and in taking the Thermometer from the Mixture, the Quicksilver continued to fall in the open Air to the 552d Degree: He threw yet into the Glass a little more Snow, pouring on it some Oil of Vitriol, and suddenly the Quicksilver fell to 1260 Degrees. Then he broke the Ball, and found the Mercury changed to a solid Body.

The Quicksilver which remained in the Tube, was also become solid, and appeared like a loose Silver Wire, attached to the Ball, which was flexible every Way. He gave the Ball of Quicksilver several Blows with a turned Ax, and it became flat like an English Half-Crown: but receiving thereby some Cracks, it dissolved in about 20 Minutes.

R. 42. In cutting a Channel for the Canal of *New* in *Ireland*, a great Multitude of fallen Trees was discovered, lying near two Miles in Length, and in many Places, six or eight Feet deep. Many of these are very large, and are tumbled down one over another, some lying in strait Lines, and others in an oblique or transverse Position. If Trees thus found had been felled by the Deluge, (as undoubtedly others were) they would all lie in one Position. But this is not the Case. We must therefore seek for other Causes. And one Cause seems to have been this. If Water flowing either from Springs or Streams be stoppt, it naturally softens and loosens the Earth; and in a Course of Time, even to the Roots of Trees, which are then subject to be overturned by any violent Storm. This doubtless was the Case with most of those Trees, that are found in Bogs with the Roots adhering to them. Trees thus falling sink into the yielding Soil, and cause a farther Stoppage in the Course of the Waters. Hence the loose Earth is increased, by a yearly Accession of Scurf, Moss, Grass and Weeds. Add to this, that the higher Lands being gradually dissolved by repeated Rains, and washed down by Floods, in a long Course of Years cover the lower Grounds with fresh Layers of Earth. This being so, it is not strange to find Trees buried eight or ten Feet under the Earth.

Another Cause may be this. Various Colonies from Time to Time arriving in the then uncultivated Country of *Ireland*, would naturally make Room for Tillage and Pasture, by clearing the Ground of its Forests. This was certainly the Case, where we find in Bogs, Trees partly burned, and others bearing the Mark of the Axe. But sometimes these Colonies were driven by the Natives from their intended Settlements, leaving the Trees they had felled strewed over the Plain, which stopping the Waters of Course created Bogs, that in Process of Time covered those Trees to a considerable Depth. Nay, as late as 1761, *Tyrene* and *O'Donnel*, marching toward *Kinsale*, through

Conaught, and laying the Country Waste, there is a great Tract of Ground, now a Bog, which was then ploughed Land.

That Bogs in general grow but slowly may be gathered from a Lump of Coins of *Edward IV.* (probably lost in a Purse which rotted away) taken up in a Bog in *Yorkshire*, eighteen Feet deep. This was about 200 Years before. So the Bog had grown about a Foot in eleven Years, that is, somewhat above an Inch in a Year: Although some seem to grow much faster.

Much more antient is the *Great Level*, or fenny Ground, which contains about 300,000 Acres, lying in the Counties of *Norfolk*, *Suffolk*, *Cambridge*, the Isle of *Ely*, *Huntingdon*, *Northampton*, and *Lincoln*. This was once firm Land. There have been found therein, Stones, Bricks, and other Materials for building. In setting down a Sluice, there was found sixteen Feet deep, a Smith's Forge, and all the Tools thereto belonging. *William of Malmshury*, who lived 1200 Years ago, says, that in his Time, "The Trees which grew there, smooth and straight, were so tall, that they seemed to touch the Stars. A Plain there is, as even as the Sea, which with the green Grass allures the Eye; and there is not the least Parcel of Ground, that lies waste and void. Here you see Plantations of Fruit-trees; there a Field set with Vines, Part creeping on the Ground, Part mounting on high Poles." But how came it to be reduced to so very different a State? It seems the Ocean broke in upon it, with such restless Violence, that the Buildings throughout the whole Space were overturned, and the Trees torn up by the Roots. The amazing Quantities of Silt thrown up at the same Time, covered the whole Country, even to the Verge of the Highlands, seven, eight, or even ten Feet deep. Hence a few Years since in digging a Pool, there was found at the upper Skirts of the Level, the Skeleton of a large Fish, near twenty Feet long, lodged in Silt above six Feet below the Surface of the Ground. Yet how or when this Inundation

was,

was, we are not able to determine. Whenever it was, it was probably occasioned by a violent Earthquake.

P. 42. A late Writer gives the following Account of the natural Origin of Bogs in *Ireland*. Some of these have vast Quantities of Timber under them: Others have very little. But the Surface of all is covered with a short, thick, and matted Kind of Heath. This as it grows and thickens at the Top, vegetates at the Bottom into a close and radacious Texture, which being replete with Moisture, throws out annual Growths of this ramified Heath, Part of which dies every Winter, and moulders at the Bottom, where it forms another Stratum, from which at Spring comes a new Crop of Heath. And thus, as these Strata of mouldered Heath are annually repeated, the Roots increase, and at once extend higher, and are more consolidated at the Bottom. Hence the Turf is ever found of a closer Texture, as we descend deeper in the Bog.

The Turf itself is only a closely concreted Combination of the Roots of this Heath, which universally grows on the Surface of these Bogs; not the Produce of the Trees, which are at the Bottom. Wherever these were thrown down, some Earth would be washed down upon them from the adjacent Grounds, the Surface of which every where produces this Heath. And this being now supplied with constant Moisture, would throw out a more plentiful Growth.

The same Cause produces these Bogs on the Sides, or even Tops of Mountains. But it is ever in wet Grounds, or in Flats on the Side of Hills, where the Water settles and supplies them with Moisture.

There seems indeed to be a spongy Quality in this Heath, which prevents the Moistures sinking away from it, by an Attraction of the Fluids, by an infinite Number of capillary Fibres, which are the very Substance of it. At the Bottom of these Mountain-Bogs,

no Trees are found. And very few in the largest Bogs, unless on the Skirts of them.

The Turf then from Top to Bottom is entirely the Produce of a Vegetation from itself. And the Reason why *Ireland* produces so many Turf-bogs, is because it so abounds with the Seeds of this Heath, which is every where found where the Land is uncultivated, and forms Bogs, wherever it has proper Moisture.

Our Marle is found only in the Bottom of low Bogs, at the Depth of seven, eight, or nine Feet. For three Feet is a spongy Sort of Earth, then Gravel for about half a Foot. For about three Feet more is a spongy Earth, mixt with Timber, but so rotten that it cuts like Earth. Next this for the Depth of three Inches we find Leaves, that are fair to the Eye, but will not bear a Touch. With these are sometimes mixt Heaps of Seed, which seem to be Broom or Furz Seed: Nay in one Place what seemed to be Gooseberries and Currants was found, and Sea-weed in others. Under this was blue Clay half a Foot thick, throughly mixt with Shells, as was also the Marle, which lay next, three or four Feet deep. They are Shells of Periwinkles: And among these are large Horns and Bones answerable thereto. But it is not only in Bogs that subterraneous Trees are found; nor in *Ireland* only, but in many Parts of *England*. At *Youle*, about twelve Miles from *York*, near the Place where the *Dun* empties itself into the *Humber*, Abundance of them have been dug up from Time to Time; all of which are a Species of Fir. In the Isle of *Axholone* in *Lincolnshire*, not Firs only but Abundance of Oaks are found in the Moor, whereof some are five Yards in Compass, with Quantities of Acorns near them. The Firs lie somewhat deeper than the Oaks; one of them was thirty-six Yards long. The adjoining Levels (about 180000 Acres) were half of them yearly covered with Water, till King *Charles I.* sold them to Sir *Cornelius Vermeyden*, who drained them at the Charge of above

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100,000l. In the Soil of all this Land, through all *Marthland*, and on the Skirts of all the *Lincolnshire* and *Yorkshire* Woods, are found Millions of Roots and Bodies of Trees, Firs, Oaks, Birch, Beech, Yew, Willow, Ash. The Roots stand in their Natural Postures, as thick as ever they could grow. The Bodies of most of the great Trees, lie all their Length about a Yard from their Roots, with their Tops North East. The smaller lie aerols in every Direction, some under, some above them. Some of the Oaks are thirty, some thirty-five Yards long, yet wanting some Yards at the small Ends. They are firm, lasting and as black as Ebony. Many of them have been burnt, some quite through, some on one Side. Some have been found chopped and squared, some bored through; some half Cleft with great wooden Wedges in them, and broken Axe-heads, shaped not unlike the sacrificing Axes. And all these were in such Places, and at such Depths, as could not have been opened, from the Time the Forest was destroyed until the Ground was drained. Near a great Root in the Parish of *Hatfield* were found eight or nine *Roman* Coins: And at the Bottom of a new Drain, were found Trees squared and cut, Rails, Bars, a Kind of Battle-axe, and two or three Coins, of the Emperor *Vespasian*. Nay, the Ground at the Bottom of the River was found to lie in Ridge and Furrow, manifesting that it had been ploughed. In an old Drain, an Oak was found forty Yards long, four Yards in Diameter at the great End. Three Yards and a Foot in the Middle, two Yards at the small End, so that by a moderate Computation, it seems to have been as long again. Yea, about fifty Years ago there was found several Feet deep, a Man lying at his full Length, with his Head upon his Arm, as asleep. His Skin, tanned as it were, by the Moor-Water, preserved his Shape intire; but his Flesh and most of his Bones were consumed.

These stately Trees formerly composed one of the most beautiful Forests in the World. But how came it to be destroyed? When the *Romans* pursued the
Britons,

Britons, they always fled into the Woods. On this the *Roman* Generals ordered them to be cut down; this vast Forest in particular. The Trees falling cross the Rivers which ran thro' the Country, soon dammed them up, turned the Ground into a Lake, and gave rise to the Moors that increased continually, by earthly Matter washed down, the Consumption of rotting Branches and Leaves, and the Growth of Water-moss, which wonderfully flourishes on rotten Grounds. Hence it is, that so many *Roman* Coins have been found at the Bottom of these Levels; that so many Trees are found burnt or chopped; and that the Soil of the Country in general is two, three or more Yards higher than formerly.

Some similar Alteration seems to have happened many Centuries ago, to that whole Tract of Land, near *Newbury* in *Oxfordshire*, out of which they dig their *Peat*. There is a Stratum of this several Miles, which lies many Feet under the Surface.

The best *Peat* has very little (if any) Earth in it, but is a Composition of Wood, Branches, Twigs, Leaves, and Roots of Trees, with Grass, Straw, Plants, and Weeds. The Colour is of a blackish Brown; and if it be chewed between the Teeth it is soft, and has no gritty Matter in it. It is indeed of a different Consistence in different Places, some being softer and some harder; which may arise perhaps from the different Sorts of Trees it is composed of. Great Numbers of Trees are visible in the true *Peat*, lying irregularly one upon another, and sometimes even Cart-loads of them have been taken out: But the nearer these Trees lie to the Surface, the less sound is the Wood; and sometimes the small Twigs, which lie at the Bottom, are so firm, as not to be easily cut through: These Trees are generally Oaks, Alders, Willows, and Firs, besides some others not easily known. The small Roots are generally perished, but yet have sufficient Signs to shew that the Trees were torn up by the Roots, and were not cut down

down; there being no Sign of the Ax or Saw, which had they been felled, would have been plainly visible. A great many Horns, Heads, and Bones of several Kinds of Deer, Horns of the Antelope, Heads and Tusks of Boars, and Heads of Bevers, are also found in it, and some human Bones.

The Islands of *Sylley* have been so noted among the Antients, one might expect to find among the Inhabitants some Consciousness of their own Antiquity, and of their Appearance in History before the other Parts of Britain were at all known. But there is nothing of this Kind, the Inhabitants are all new comers, not an old Habitation worth Notice, nor any Remains of Phœnician, Grecian, or Roman Arts, either in Town, Castle, Port, Temple, or Sculpture.

We are not to think however but *Sylley* was inhabited, and was as frequently resorted to antiently, as the old Historians relate. All the Islands (several of which are now without Inhabitant) by the Remains of Walls, Foundations of many contiguous Houses, and a great Number of Sepulchral Burrows, shew, that they have been fully cultivated and inhabited.

That they were inhabited by *Britons*, is past all Doubt, not only from their neighbourhood to *England*, but from the Druid Monuments, Several rude Stone Pillars, Circles of Stones erect, Rock-basins; All Monuments common in *Cornwall* and *Wales*, are equal Evidences of the Antiquity, Religion, and Original of the old Inhabitants.

How came these antient Inhabitants then (it may be ask'd) to vanish, so as that the present have no Pretensions to any Affinity of any Kind with them, either in Blood, Language, or Customs? How came they to disappear, &c. leave so few Traces of Plenty, or Arts, and no Posterity behind them? From two Causes, the manifest Incroachments of the Sea, and as manifest a Subsidence of some Parts of the Land.

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The Sea is the insatiable Monster, which devours Islands, gorges itself with the Earth, Sand, Clay, and all the yielding Parts, and leaves nothing where it can reach, but the Skeleton, the bared Rock. The continual Advances, which the Sea makes upon the low Lands, are plain to all People of Observation. What we see happening every Day may assure us of what has happened in former Times, and from the Banks of Sand and Earth giving way to the Sea, and the Breaches becoming still more open, and irrecoverable: it appears, that repeated Tempests have occasioned a gradual Dissolution of the Solids for many Ages.

Again, the Flats which stretch from one Island to the other, are plain Evidences of a former Union between many now distinct Islands. The Flats between some of them are quite dry at a Spring-tide, and Men easily pass dry shod from one Island to the other, over Sand-banks (where, upon the shifting the Sands, Walls and Ruins are discovered frequently) upon which at full Sea, there are ten and twelve Feet of Water.

All strong Arguments that these Islands were once one continued Tract of Land, though now, as to their Low-lands, over-run with the Sea and Sand. History confirms their former Union. "The Isles *Cassiterides* (says *Strabo*) are ten in Number, close to one another; one of them is desert and unpeopled, the rest are inhabited." But see how the Sea has multiplied these Islands, there are now reckoned 140. Into so many Fragments are they divided, and yet there are but six inhabited. But no Circumstance can shew the great Alterations, which have happened in the Number and Extent of these Islands, more than this, viz. that the Isle of *Sylly*, from which the little Cluster takes its Name, is no more at present than a high Rock, of about a Furlong over, whose Cliffs hardly any Thing but Birds can mount, and whose Barrenness could never suffer any Thing but Sea-birds to inhabit it. How then came all these Islands

Islands to have their general Name from such a small and useless Plot?

Doubtless *Sylley*, which is now a bare Rock, and separate from the Lands of *Guel* and *Brehar* by a narrow Frith, was formerly joined to them by low Necks of Lands, being the rocky Promontory of one large Island now broke into seven. This Promontory (at present called *Sylley Island*) lying Westermost of all the high Lands, was the first Land of all the Islands discerned by the Traders from the *Mediterranean* and *Spanish* Coasts, and, as soon as discovered was said to be *Sylley*, nothing being more usual with Sailors, upon their first seeing Land, than to call the Part by the Name of the whole. But when this considerable Island called *Sylley* was broken to Pieces, the greatest Portions became inhabited, and had first *British* Names, as *Brehar*, *Trescaw*, *Enmor*; but afterwards were called according to the Religion of the Times, after the Names of particular Saints. The chief Division was intitled *St. Mary's*, the others dedicated to *St. Nicholas*, *St. Martin*, *St. Theon*, and so on; but this remarkable Promontory being in no wise fit for Habitation or Devotion, was dedicated to no Saint, but left to enjoy its antient Name; and, notwithstanding the modern Christian Dedications, Sailors went on in their old Way. This high Land is still called *Sylley*, and the Islands in general are still denominated *Sylley Isles*.

It must have been a dispiriting Circumstance to the old Inhabitants, to see the Ocean so continually eating away their Low-lands, in which they had their Treasures of Tin, their houses and Ports: But this gradual Decay was not the only Misfortune, which attended them. From the Island of *Sampson*, one may see the Foundations of Stone-fences running on in a strait Line cross the Frith, towards *Trescaw* Isle, till they are hid in the Sand, which Sand, when it is full Tide, has from ten to twelve Feet Water on it. Now we cannot suppose that the Foundation of these Fences was laid as low as high Water

Water Mark, (for who would build Fences upon so dangerous a Level ?) at a Medium we may suppose them to have been laid six Feet above the full Tide.

Here then we have the Foundations, which were six Feet above the High-water Mark, now ten Feet under, which together make a Difference as to the Level of sixteen Feet.

Here then was a great Subsidence, which must have been follow'd by a sudden Inundation, and this Inundation is likely not only to have destroyed a great Part of the Inhabitants, but to have terrified others who survived into a total Desertion of their shattered Islands. By this Means that considerable People, who were the Aborigines, and carried on the Tin Trade which the *Phenicians*, *Greeks*, and *Romans*, were reduced to the last Gasps. The few poor Remains of this Desolation by their necessary Attention to Food and Raiment, must soon have lost Sight of their ancient Prosperity, and the faint Remembrance, that was left of what the Islands had been before, expired of itself in an Age or two, thro' the Indigence of the Inhabitants.

That such an Inundation has happen'd here, is still more plain, because these Islands are no longer what they were antiently, fertile in Tin ; nor are there any Remains of so many antient Workings as could maintain a Trade, so greedily coveted by the Antients. But what is become of those Mines ? how shall this Question be answered, but by confessing that the Land, in which they were, is now sunk, and buried under the Sea ?

I am not fond of introducing Earthquakes ; but where there has been evidently a great Subsidence of the Earth's Surface, can it be accounted for at all without a previous Concussion of the Earth ? And what Nature declares in this Case, Tradition seems to confirm ; there being a strong Persuasion in the Western Parts of *Cornwall*, that formerly there existed a large Country between the *Land's-End* and *Sylley*,

now

now laid many Fathoms under Water. Indeed there are no Evidences of any ancient Connexion of the *Land's-End* and *Sylley*. Yet that the Cause of that Inundation, which destroyed much of these Islands, might reach also to the *Cornish* Shores, is extremely probable; there being several Evidences of a like Subsidence of the Land in *Mount's-Bay*. The principal Anchoring-place, called a Lake, is now a Haven or open Harbour. The Mount from its *Cornish* Name, we must conclude to have stood formerly in a Wood; but now at full Tide, it is half a Mile in the Sea, and not a Tree near it; and in the sandy Beach betwixt the Mount and *Penzance*, when the Sands have been dispersed by violent high Tides, there have been seen the Trunks of several large Trees in their natural Position, the Surface of their Section worn smooth by the Agitation of the Water, Sand, and Gravel, as if cut with an Axe, upon which at every full Tide, there must be twelve Feet Water; so that the Shores in *Sylley*, and the neighbouring Shores of *Cornwall*, are concurrent Evidences of such a Subsidence, and the Memory of the Inundations, which were the necessary Consequences of it, is preserved in Tradition; the like other Traditions, in Proportion to their Age, obscured by Fable.

That there has been such a Subsidence, of the Lands belonging to these Islands, the present Ruins of the Islands testify. And this Subsidence reached even to *Mount's-bay*, and laid under Water a great Part of the Low-lands, then Woody, there being now ten Feet Water, so that the Shores in *Sylley* and the Shores in *Cornwall*, are equal Proofs of such Inundation. When this Inundation happened, we know not; but two Pieces of History, possibly may lead us near the Time. In the Time of *Strabo* and *Diodorus Siculus*, their Commerce was in full Vigour, "Abundance of Tin was carried in Carts," say *Diodorus Siculus*.—"But ten Islands in all (says *Strabo*) and nine of those inhabited." The Destruction therefore

of *Sylley* must be placed after the Time of these Authors, that is, after the *Augustan* Age.

Now *Plutarch* hints, that the Islands round *Britain* were generally unpeopled in his Time. If he includes *Sylley* among them, then this Dissolution must have happened between the Reign of *Trajan*, and that of *Augustus*.

Before we dismiss the Article of Bogs, it may not be improper to subjoin as strange an Account as hardly any Age can parallel. June 7, 1697, near *Charleville* in *Ireland*, a great rumbling was heard in the Earth. Soon after, in the Bog of *Kapanihane*, stretching North and South, some Meadow and Pasture-Land, that lay on the Side of the Bog, separated by a large Ditch, and other Land on the further Side adjoining to it, began to move: And a little Hill in the Middle of the Bog, sunk down.

This was at Seven in the Evening, the Ground fluctuating in its Motion, like the Waves of the Sea. The Pasture-land then rose up, over ran the Ground beneath, and moved upon its Surface, rolling on with great Violence, till it had covered the Meadow sixteen Feet deep. It drew after it the Body of the Bog, Part of it lying on the Place, where the Pasture-land was before, leaving great Breaches behind it, and Currents of Water, which cast up noisome Vapours. There are still Cracks and Chasms through the whole Surface of the Bog, which contains forty Acres.

But we have a later Incident of the same Kind. On Saturday, January 26, 1745, a Part of *Pilling-moss*, lying near *Hefcomb*-houses, was observed to rise to a surprizing Height. After a short Time, it sunk as much below the Level, and moved slowly toward the South-side. In half an Hour it covered 20 Acres of Land. The improved Land, adjoining to that Part of the Bog, is a concave Circle, containing near an hundred Acres, which is well nigh filled up
with

with Bog and Water. In some Parts, it is thought to be five Yards deep.

An intense Frost retards its Progress for the present, but it is likely to spoil a great deal more Land. That Part of the Moss, which is sunk like the Bed of a River, runs North and South. It is above a Mile in Length, and near half a Mile in Breadth.

The Discovery of the *Bones of Elephants* at the Bottom of some of our *English Bogs*, seems a convincing Proof, that the Earth has undergone some very extraordinary Alterations. For the Remains of Animals of quite different Climates, which in the present Situation of the World, could never possibly come over hither, must imply, either their having been originally here, or that *England* was once joined to the Continent. But since we find these Creatures only in very hot Countries, it is highly probable, they were not originally here, unless we suppose the Temperature of our Climate to have been greatly altered. And without such a Supposition, we cannot suppose they would have wandered hither, though all Parts of the Globe had been contiguous. But what Changes have happened to our Earth, no human Wisdom can find out. Suppose only the Axis thereof to have been shifted at any Time but a few Degrees, what Convulsions in Nature, what an universal Change in the Face of Things must have ensued? What Inundations of Water, bearing every Thing before them? What Breaches in the Earth, what Hurricanes and Tempests, must have attended such an Event? For the Waters must have rolled along, till an Equipoise was produced. And all Parts of the World must acquire different Degrees of Heat and Cold from what they had before. Seas would be formed, where Continents had been; Continents torn in Pieces, or split into Islands. Such would have been the Fate of inanimate Things. And as to living Creatures, they must have been

destroyed and buried in the Ruins of the World, as perhaps these Elephants were.

There is something remarkable in the Manner, wherein the Tides rise, in several of our Rivers. In the River *Severn*, in particular, near *Newnham*, and 160 Miles from *Lundy*, the Head of the Flood at Spring-tides rises in Height like a Wall, near nine Foot high. Thus it pours on for many Miles, usually oversetting any Vessels that lie in its Way. This Head-tide they call the *Boar*: It flows here only Two, and ebbs ten Hours.

But how shall we account for the ebbing and flowing of *Lay-well*, near *Torboay*? This ebbs and flows many Times in an Hour. It usually performs its Flux and Reflux in a Minute's Time. But it stands two or three Minutes after the Ebb: So that in the whole it ebbs and flows about sixteen Times in an Hour.

Will it be improper to mention here, a cheap and easy Way, of making *Sea-water fresh*? "I took, says a Gentleman, a long Glass Body, and having filled it with Sea-water, put therein *Sea-weed* with its Roots, fresh and new-gathered. Then I put on a Head and a Beak, and adapted a Receiver thereto, without any Lute or closing the Joints. From the Plants distilled daily a small Quantity of very sweet and potable Water, which had no unpleasant Taste, as that distilled by Fire always has. And probably there may be found other Plants near the Sea, which would yield fresh Water in larger Quantities.

P. 45. Does not the following Instance shew, that there is an *under Current* at the Mouth of the *Mediterranean Sea*? In the Year 1712, *Monf. l'Aigle*, Commander of a Privateer, chasing a Dutch Ship near *Ceuta Point*, came up with her in the Straits between *Tariffa* and *Tangier*, and giving her one Broad-side, sunk

A few Days after this Ship with her Cargo of Brandy and Oil, arose near *Tangier*, four Leagues West of that Place where she sunk, and directly against the Strength of the Current. Certainly then the deep Water in the Middle of the Strait, sets outward to the Grand Ocean. And possibly great Part of the Water, which runs in at the Straits, may run out again that Way.

One of the most violent Currents in the Northern Seas, runs between two of the *Western Isles*. The Sea begins to boil with the Tide of Flood, and increases gradually, till there are many Whirlpools, which form themselves in a Sort of Pyramids, and immediately spout up as high as the Mast of a little Vessel. At the same Time they make a loud Report. These white Waves run two Leagues before they break. The Sea continues these Motions, till it is more than half Flood, and then decreases gradually, till it has ebb'd half an Hour. From that Time it boils again, till it is within an Hour of Low-water. This boiling of the Sea is about a Pistol-shot distant from the Isle of *Scarba*. But the smallest Boat may safely cross the Gulp, at the last Hour of the Flood or of the Ebb.

V. II. P. 46. In like Manner, the Collision of the opposite and oblique Streams, near the End of the *Orkney Islands*, excites a circular Motion in the Water, and when the Swiftness of the Tide is inconsiderable, occasions Whirlpools or Cavities in the Sea, in the Form of an inverted Bell, wide at the Mouth, and growing gradually narrower toward the Bottom. Their Width and Depth are in Proportion to the Rapidity of the Streams that cause them. Those in *Pentland Firth*, near the Islands *Stroma* and *Saona*, will with a Spring-tide, turn any Vessel quite round. There have been Instances of Boats being swallowed up in them. The Cavity is largest, when it is first formed, and is carried along with the Stream, diminishing.

minishing gradually as it goes, until it disappears. The Suction communicated to the Water, does not extend farther than the Cavity. When Fishermen are aware of their Approach to one of these *Wells*, as they call them; and have Time to throw an Ore or any other bulky Body into it, before they are too near, the spiral Motion is interrupted, and the Continuity of the Water broke, which rushing in on all Sides, fills up the Cavity, and enables them to go over it safe.

P. 50. Is it not remarkable, that *Sand* is a more effectual Barrier against the Sea than *Rock*? Accordingly the Sea is continually gaining upon a rocky Shore: But it is continually losing on a sandy Shore, unless where it sets in with an *Eddie*. Thus it has been gaining from Age to Age, upon the *Isle of Portland* and the *Land's-End* in *Cornwall*, undermining, throwing down and swallowing up one huge Rock after another. Meantime the sandy Shores both on our Southern and Western Coasts, gain continually upon the Sea.

C H A P II.

Of Fire and Air.

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| 1. The Effect of Fire in <i>Vacuó</i> : | 6. Of <i>Monte Secco</i> : |
| 2. Fire increases the Weight of Bodies: | 7. Of <i>Monte Nuevo</i> : |
| 3. Nearness to the Sun, not the sole Cause of Heat: | 8. New Islands: |
| 4. Of Mount <i>Vesuvius</i> : | 9. An Island burnt up: |
| 5. Of <i>Herculanum</i> : | 10. A burning Mountain in <i>Ternato</i> : |
| | 11. A Journey to Mount <i>Hecla</i> : |
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| 22. Destruction of Port Royal in Jamaica : | 22. Persons consumed by internal Fire : |
| 23. ——— of Lima : | 23. Sparkles from a Persons Cloaths : |
| 24. ——— of Collao : | 24. Of the Bologna Phial : |
| 25. A remarkable Deliverance : | 25. Of the Glass-drop : |
| 26. Of Pooles and Elden-Hole : | 26. Air is in all our Fluids : |
| 27. Earthquakes caused by Electricity : | 27. — is the cementing and dissolving Principle : |
| 28. Account of a burning Well : | 28. — increases the Weight of Oil and Vitriol : |
| 29. ——— of one near Brosely : | 29. — capable of immense Expansion : |
| 30. A Fire of the same Kind : | 30. Difference between fixt and common Air. |
| 21. A burning Vapour : | |

V. II. P. 59. **FIRE** has some Effect on most Bodies, even in an exhausted Receiver. One placed a black Ribbon therein, and then applied a Burning-glass. Abundance of Smoke issued out of it, which fell by little and little, and the Ribbon appeared not at all changed. But when it was touched, after the re-admission of the Air, it presently fell into Ashes.

The Glass being applied to Gun-powder so inclosed, it burnt Grain by Grain, but none of the Grains kindled. Another Time, when the Sun had less Force, they would not burn, but only boiled and emitted Smoke. This Smoke falling on the Board on which the Powder lay, was of the Colour of Brimstone. The Powder that remained, being put on Coals, burned like Salt-petre, inasmuch as the Brimstone had exhaled.

Tin and Copper melted together weigh more than both Bodies did before. Yea, Orpin being mixt with Salt of Tartar, is heavier by a fifth Part.

To resolve this, it has been commonly supposed, that Fire adds to the Weight of Bodies. But Fire has itself no Weight at all: Therefore it can give none. Pure Fire as Dr. *Hillary* observes, is a Body without Gravity, and has no more Tendency to any one Part of Space, than to any other.

Is not then this Alteration of Weight rather owing to an Alteration of the inward Texture of the Particles, in the Body calcined? The lighter Particles being removed by Exhalation, do not these remaining approach nearer each other? And must not then the Weight, which is always as the Solidity, increase accordingly?

Very different Degrees of Heat obtain in the same Latitude, on the different Sides of the *South American Continent*: Which shews that the Temperature of a Place depends much more upon other Circumstances, than upon its Distance from the Pole, or Nearness to the Equinoctial. Thus though the Coast of *Brazil* is extremely sultry, yet the Coast of the South Seas in the same Latitude, is quite Temperate, and in ranging along it, one does not meet with so warm Weather, as is frequent in a Summer's Day in *England*: which is the more Extraordinary, as there never falls any Rain to refresh and cool the Air. On the Coast of *Peru*, even under the Line, every Thing contributes to make the Day agreeable. In other Countries, the scorching Sun in Summer, makes the Day unfit either for Labour or Amusement: And the Rains are no less troublesome, in the cooler Parts of the Year. But in this delightful Climate, the Sun rarely appears; for there is constantly a grey, cheerful Sky, just sufficient to screen the Sun, without obscuring the Air. Thus all Parts of the Day are proper for Labour, while the Coolness produced elsewhere by Rains, is here brought about by fresh Breezes, from the cooler Regions.

This is chiefly owing to the *Andes*, which running not far from, and nearly Parallel with the Shore, and rising immensely higher, than any other Mountains

tains in *America*, or perhaps on the Globe, form on their Sides a prodigious Tract of Land, where according to their different Heights, all Kinds of Climates may be found, at all Seasons of the Year. These Mountains intercept great Part of the Eastern Winds, which generally blow on the Continent of *America*, cool that Part of the Air which comes over their Tops, and keep it cool by the Snows, with which they are always covered. Thus by spreading the Influence of their frozen Crests, to the Neighbouring Coasts and Seas, they cause the Temperature and Equability, which constantly prevail there. But when they leave these Mountains, they experience in a short Time an entire Change of Climate, and in two or three Days, pass from the temperate Air of *Peru*, to the sultry Atmosphere of the *West-Indies*.

P. 63. The fiery Erruptions of Mount *Vesuvius* strike the Neighbourhood with Horror. But as even noxious Things bring some Advantage with them, so this Mountain by the sulphureous and nitrous Particles with which it manures the Ground, and the Heat of its subterraneous Passages, much contributes to its uncommon Fertility. And wherever these inflammable Substances abound, 'tis better they should have a Vent than not. So Experience shews, that this Country has had fewer Earthquakes, and those less fatal in their Effects, since the Eruption of the subterraneous Matter, through the Mouth of *Vesuvius*. And the Inhabitants are not much alarmed, at seeing the usual vernal Explosions. They began in the Year 1730, in the End of February. The Smoke rose directly up in the Air, like a large black Pillar, and then expanded itself in long Streaks, resembling thick Clouds. In the Night, almost after every Explosion, a short fiery Pillar was seen to shoot up, consisting chiefly of red-hot Stones, thrown up in a perpendicular Direction.

The Distance from *Naples* to the Foot of *Vesuvius*, is six Italian Miles, from whence to the Top is near three

three Miles further. It properly consists of two Hills, though one of them only, emits Fire and Smoke. The Valley between them is about a Mile long, and extremely Fertile. The burning Summit, which is the lowest of the Two, is Eleven hundred Fathoms above the Surface of the Sea. From *Resina*, the Ascent grows steeper, and many Stones are scattered about, as Memorials of its former Devastations. It is astonishing to think of the Force, by which such huge Bulks of 4 or 500 Hundred Weight have been thrown several Miles from the Hill.

This being steep, and covered with black Ashes, the Ascent is very Difficult. From the Mouth frequently issues a Flood of *Lava*, or Composition of Sulphur, Metals and Minerals. This ejected Matter lies still one Layer above another, with large Stones projecting above the Surface, which in their Course along the fiery River, were stopped by their Inequalities, and fixing in the melted Matter, gradually hardened. These Streams are not thrown up from the Mountain, like the Stones, but pour down, as from an inclined Vessel; proceeding, it seems, from the whole Cavity, which is then full of melted Substances.

About half Way up the Mountain (says Mr. Keyser) we met with Stones of above an hundred Weight glowing hot, which when broken had exactly the Appearance of red-hot Iron. As we went on, we heard a most horrid Noise, resembling the Discharge of a whole Battery of Cannon, and under our Feet we perceived a rumbling, like the Boiling of a large Caldron. At last we reached the Place where the largest Volcano was formerly situated. But it is now not only choked up, but covered with a round Pill of Ashes and Lava. Thirty Years since, there was a Plain of about 3000 Yards to cross, before you came to the Skirts of this new Mountain. But it is now enlarged, that in most Places, the Plain is but about thirty Yards broad. Probably in a few Years it will be quite filled up, and the two Mountains joined

one. Here the Increase of Heat was very sensible, especially at every Explosion, when the Ashes flew so strongly in our Faces, that we were obliged to cover our Eyes. The Ground also was so hot under our Feet, that it burnt the Soles of our Shoes. Every Eruption was attended, with a whizzing Noise, like that of many Rockets thrown up at once. The Clouds of Smoke, and Multitude of Stones thrown into the Air, totally obscured the Sky. Most of the Stones, especially if large, fell again into the Abyss from which they are projected. Great Quantities, however fell on the Sides of the Mountain, and rolled down with an hideous Noise.

Even when all is still, the Bottom of the Cavity is seldom seen, by Reason of the Smoke. When it is, it is subject to great Variation. Sometimes it is of a prodigious Depth; at other Times hardly more than an Hundred Feet, according to the rising or falling of the melted Matter, since the last Erruption, by the hardening of which, this Bottom is formed.

Since the Birth of Christ, there are recorded upwards of twenty memorable Eruptions of *Vesuvius*. One of the most Violent was, that which happened in the Reign of *Titus Vespasian*, and destroyed the Cities *Herculanum*, *Stabice* and *Pompei*, which then stood near *Naples*. During that Eruption the Ashes were driven as far as *Africa*, *Syria*, and *Egypt*, and even at *Rome*, the Sun was darkened by them. These Cities were partly swallowed up, partly buried in the burning Lava, so that not the least Remains of them were to be seen.

But within a few Years many Things have been dug up out of *Herculanum*, near *Portici*, the King of *Naples* Palace. Among these are many Paintings, done in Stucco, in Water Colours, in Fresco. They have been taken from the Walls of an Amphitheatre, a Temple, and several Houses, and are in great Variety, some perfectly well preserved.

Four capital Pieces are so extremely well executed that *Don Francesco de la Vega*, a Painter, whom the King

King of Naples sent for from Rome, to take Draughts of these Paintings, said, " If Raphael were alive, he would be glad to study these Drawings, and perhaps take Lessons from them." Nothing can be more just and correct. The Muscles are exactly and softly drawn, every one in its own Place, without any of that preternatural Swelling seen in the Works of some of the best Italian Masters. And it is surprizing to see how fresh the Colours are, considering they have been under the Ground above sixteen hundred and fifty Years.

The Matter thrown out of *Vesuvius*, shews whence its fiery Eruptions arise. For, pour Water on Sulphur, mixt with Filings of Iron, and it soon breaks out into a Flame. That Abundance of Sulphur and Iron is contained in *Vesuvius*, appears not only from what is ejected, but also from the Mineral Water, issuing from the Foot of the Mountain. The neighbouring Sea both supplies Moisture to these inflammable Substances, and also Salt and Bitumen. That *Vesuvius* has a Communication with the Sea, Experience shews; the Waters being surprizingly absorbed, in 1681, before the Eruption, so that the several Vessels before afloat were left dry. Likewise in 1698, the Sea suddenly ebbed twelve Paces, and the Mountain discharged a Torrent of bituminous Matter. When the Discharge ceased, and the Sea returned to its former Height, great Quantities of Shells, half burnt, and emitting a sulphurous Smell, were found along the Shore. In another violent Eruption, not only Shells, but Sea-weeds, and hot Sea-water were ejected. This Volcano, however, affords several fresh Springs, some of which are conveyed to Naples, by a beautiful Aqueduct. These Waters have not the least Heat in them. Nay, a cold Wind is felt to blow, from several Fissures and Chasms of the Mountain.

P. 65. Near *Puzzuolo* lies *Monte Sacco*, which is *Vesuvius* in Minature. Its Summit, formerly a Cone, is now sunk into a concave Oval, whose shortest Dia-

meter

meter is about 1000 Feet, the longest 1246. It is generally known by the Name of *Solfatara*. Tho' *Vesuvius* is twelve Miles distant, yet they have a Communication with each other. Hence the subterraneous Fire is quiet at *Solfatara*, when it has a Vent at *Vesuvius*: Whereas the Heat at the former increases, when the latter is at rest.

On this Mountain are many Cracks emitting Smoaks; the Heat issuing from them is sometimes insupportable. Hold a Piece of Iron over one of these Cracks, and a sweetish Fluid will drop from it: But a Piece of Paper, instead of being moistened, grows quite dry and stiff. The Stones near these Cracks are in continual Motion; and small Stones dropt into them, are ejected to the Height of twelve Feet, like the ponderous Masses from *Vesuvius*. In some Places, the Sand by the Force of the Vapours, Springs up and down, like the Sparkling of Cyder.

Out of *Solfatara* they extract beside Sulphur, blue Vitriol, and the best Kind of Alum. The large leaden Kettles used herein, are not heated by a culinary Fire, but by the natural Heat issuing through Holes in the Ground, over which the Vessels are placed.

Not far from *Puzzuolo* is the *Monte-Nuovo*, which rose suddenly in the Night, between the 19th and 20th of September, 1636. During a dreadful Earthquake that laid the whole Neighbourhood in Ruins, the subterraneous Fire, opening a large Chasm in the Ground, threw out such Quantities of Stones, Ashes, Bitumen and Sand, as in twenty-four Hours formed this Mountain. Its perpendicular Height is 400 Rods, its Circuit three Miles. The Edge of the first Adventure is still visible, a Mile in Circuit, though it is now intirely filled up.

An Event similar to this occur'd more lately. After a Shock of the Earth, there was seen from *Santorini* (an Island in the *Archipelago*, on the Coast of *Natolia*) on the 23d of May 1707, as it were a floating Rock. Some were so bold, as to go down upon it, even

while it was growing under their Feet. The Earth of it was very light, and contained a small Quantity of Potters Clay. It increased daily, till it was half a Mile in Circumference, and twenty or twenty-five Feet high. At this Time a great Ridge of Rocks, dark and black, rose out of the Sea, and joined to the new Island. Then there issued out of it a thick Smoke, with a Noise like constant Thundring, or a Discharge of many Cannon at once. The Sea-Water continually bubbled up; and in a short Time the new Land presented nothing to view for whole Nights, but a great Number of Stoves, which cast forth Flames, with Showers of Ashes, and innumerable small Stones, red-hot. Rocks were also darted out of these burning Furnaces, which mounted up like Bombs. This continued till November.

There is likewise an Island among the *Azores*, which had the same Original. On the Night between the 7th and 8th of December, 1720, there was felt a Shock of an Earthquake at *Tenera*; and presently after, an Island rose, from the Midst of boiling hot-water. It was nearly round, and high enough to be seen seven or eight Leagues off. But after a little while it sunk, till it became level with the Water.

On June 4th, 1693, the Mountain on the Island *Torca* in the *East-Indies*, began, about Day-break, to cast out more Fire than usual, which continued five or six Days, till at last it poured forth, not only a prodigious Flame, but likewise such a black and sulphurous Vapour, that the Inhabitants of *Hillo* (a Village in the Western Part of the Island, and nearest to the Opening) were wholly covered by it. Quickly followed a Stream of burning Brimstone, which consumed many that could not escape. Afterwards the Inhabitants perceived, a great Part of the Mountain was sunk down. Another Part sunk three or four Days after, and so from Time to Time, till the burning Lake covered near half the Island. Wherefore they

they went on board their Boats; from whence they perceived huge Pieces of the Mountain fall into the fiery Lake, with a prodigious Noise, as if a whole Battery of Cannon was discharged. The Inhabitants of another Town on the East Side of the Island, not thinking themselves in so great Danger, remained a Month longer. But the fiery Lake approaching nearer and nearer, so that there was no doubt but it would swallow up the whole Island, they too fled for their Lives and arrived at *Amboina*, July the 18th, 1693.

In the Mountains of *Ternata*, a terrible Noise is continually heard. The Fire frequently casts out Stones, and lies exceeding deep. Probably the burning Mountains in the *Molucca* Islands are consumed beneath by the same Fire.

Manilla is one of the largest of the *Philippine* Islands. The City is much larger than *Oxford*, is an University, and is inhabited only by *Spaniards*. The Houses are large and built very strong. The lower Walls are Stone, and of a prodigious Thickness. All above is Wood, and every Piece of Timber has a Connection with the others, and all are jointed together that the Earthquakes, which are very frequent, may not throw them down. In 1750, they had an Earthquake with almost continual Tremblings for three Months. Then followed an Eruption in a small Island, surrounded by a large Lake which is unfathomable. The third Day after the Eruption began, there arose in the Lake four more small Islands, all burning. About a Mile from one of these, there is a Fire rising continually out of the Water, in a Part where there is no Ground for above an hundred Fathom.

A particular Account of a Journey to Mount *Hala*, is given by a late Author. We travelled, says he, two Days in rugged and unfrequented Roads. Then we came within six Miles of the Mountain, and perceived the Ground strewed with Ashes and Pumice Stones, over which we passed to the Foot of it. The

Weather being serene and calm, and no Flames issuing out of the Vólcano, we resolved to go to the Top; till being informed by our Guides, that if we went any further, we should be in Danger of falling into Pits, where we might be suffocated by the Fumes rising out of the Earth, all my Company declined it. I told them, if they would stay for me, I would go alone. They promised they would. So I alighted and prepared to go up, when one of them offered, to go up with me.

Having given our Horses to our Guides, who stayed with the rest of our Company, we ventured forward, resolving to reach the Top, and in a short Time saw a large Flight of Crows and Vultures, that had their Nest in the Top of the Mountain. Having ascended about half a League, we felt the Ground shake under us, and heard a terrible Noise, in the Bowels of the Earth, just as if it was going to burst open. At the same Time there appeared on all Sides Chinks, out of which issued bluish Flames, with a strong suffocating Smell. This made us turn back, for fear of being burnt to Ashes. But we had scarce proceeded thirty Yards back, before a black Cloud of Smoke ascended out of the Mountain, obscured the Light of the Sun, and covered us so thick, that we could not see each other. Our Fears increased every Step we took; for behind us came Flames of Fire, with Showers of Ashes and Pumice Stones, which fell as thick as Hail. This dreadful Storm was attended with horrible Noises, and we expected every Moment, the Earth would open and swallow us up. This added Wings to our Flight, so that in a Quarter of an Hour we got to the Bottom of the Mountain.

P. 63. Of the great Earthquake at *Port-Royal*, in *Jamaica*, an Eye-witness writes thus. It happened on January 7, just before Noon, and in the Space of two Minutes, shook down and drowned nine Tenals of the Town. The Houses sunk outright thirty or forty Fathom. The Earth opened and swallowed up the

the People, in one Street and threw them up in another: Some rose in the Middle of the Harbour. While the Houses on one Side of a Street were swallowed up, those on the other were thrown on Heaps. The Sand in the Street, rising like Waves in the Sea, lifted up every one that stood upon it. Then suddenly sinking into Pits, the Water broke out and rolled them over and over. Sloops and Ships in the Harbour were overset and lost: The Swan Frigate was driven over the Tops of many Houses. All this was attended with a hollow, rumbling Noise. In less than a Minute, three Quarters of the Houses, with their Inhabitants, were all sunk under Water: And the little Part which remained was no better than an Heap of Rubbish. The Shock threw People down on their Knees or their Faces, as they ran about to look for Shelter. Several Houses which were left standing, were removed some Yards out of their Places. One whole Street was made twice as broad as before. In many Places the Earth cracked, opened and shut, with a Motion quick and fast. And two or three Hundred of these Openings, might be seen at a Time. In some of these People were swallowed up, in others caught by the Middle and prest to death. In others, the Heads of Men only appeared, in which Condition Dogs came and ate them. Out of some of these Openings, whole Rivers of Water spouted up a prodigious Height: And out of all the Wells the Water flew, with a surprizing Violence. The whole was attended with a noisome Stench, and the Noise of falling Mountains at a Distance, while the Sky in a Minute's Time turned dull and reddish, like a glowing Oven. And yet more Houses were left standing at *Port-Royal*, than in all the Island beside. Scarce a Planter's House or Sugar-work was left throughout all *Jamaica*. A great Part of them was swallowed up, frequently Houses, People and Trees at one Gap, in the Room of which there afterwards appeared, a large Pool of Water. This when dried up, discovered nothing but Sand, without any Mark that House or Tree

had been there. Two Thousand People lost their Lives: had it been in the Night, few would have escaped. A Thousand Acres of Land were sunk: One Plantation was removed half a Mile from its Place. Yet the Shocks were most violent among the Mountains. Not far from *Yall-house*, Part of a Mountain, after it had made several Leaps, overwhelm'd a whole Family and great Part of a Plantation, though a Mile distant. A large Mountain, near *Port Morant*, about a Day's Journey over, was quite swallowed up, and in the Place where it stood, remained a Lake, four or five Leagues over. Vast Pieces of Mountains with all the Trees thereon, falling together in a confused Manner, stopped up most of the Rivers, till swelling abroad, they made themselves new Channels, tearing up every Thing that opposed their Passage, and carrying with them into the Sea, such prodigious Quantities of Timber, that they seemed like moving Islands. In *Liguania* the Sea retiring from the Land, left the Ground dry for two or three Hundred Yards. But it returned in a Minute or two and overflowed a great Part of the Shore. Those who escaped from the Town got on board the Ships in the Harbour, where many continued two Months: The Shakes all the Time being so Violent, that they durst not come on Shore. The noisome Vapours occasioned a general Sicknes swept away three Thousand of those that were left.

The following Account of this memorable Event is given by the Rector of *Port-Royal*.

On Wednesday, June 7, I had been reading Prayers, (which I have read every Day since I came to *Port-Royal*, to keep up some Shew of Religion among a most ungodly People) and was gone to the President of the Counsel. We had scarce dined, when I felt the Ground heave and roll under me. I said, "Sir, what is this?" He replied composedly, "It is an Earthquake. Be not afraid; it will soon be over." But it increased more and more: And presently we heard the Church and the Tower fall. Upon this we

ran

ran to save ourselves : I quickly lost him; and ran toward *Morgan's-Fort* ; as that was a wide, open Place, and secure from the falling Houses. As I ran, I saw the Earth open, and swallow up Multitudes of People, and the Sea mounting over the Fortifications. I then laid aside all Thought of escape, and went homeward, to meet Death in as good a Posture as I could. I was forced to go through two or three narrow Streets, the Houses fell on each Side of me. Some Bricks came rolling over my Shoes, but none hurt me. When I came to my Lodging, I found all Things in the same Order that I left them. I went to the Balcony, and saw that no Houses in our Street was fallen. The People seeing me, cried to me, to come and pray with them. When I came into the Street, every one laid hold on my Cloaths and embraced me. I desired them to kneel down in a Ring, and prayed with them near an Hour, till I was almost spent between the Exercise, and the Heat of the Sun. They then brought me a Chair, the Earth working all the Time, like the rolling of the Sea, insomuch that sometimes while I was at Prayers, I could hardly keep on my Knees. By the Time I had been half an Hour longer with them, in setting their Sins before them, and exhorting them to Repentance, some Merchants came, and desired me to go on Board one of the Ships in the Harbour from the Top of some Houses which lay Level with the Water. I got into a Boat and went on Board the *Sixm-Merchant*. The Day when this happened was exceeding clear, and afforded no Suspicion of Evil. But about half an Hour past Eleven, in less than three Minutes, *Port Royal*, one of the fairest Towns in the *English Plantations*, was shattered in Pieces, and left a dreadful Monument of the Justice of God.

About ten Years after the Town was rebuilt a terrible Fire laid it in Ashes. Yet they rebuilt it once more. But in the Year 1722, an Hurricane reduced it a third Time to an Heap of Rubbish. Warned by these

these extraordinary Calamities, which seemed to mark it out as a devoted Spot, they removed the public Offices from thence, and forbid any Market to be held there for the future.

Perhaps we have not in History many more remarkable Deliverances than that of this good Man. But more remarkable, if possible, is the following Deliverance, from a Danger of a very different Kind.

In the Neighbourhood of *Demonte*, as one descends through the upper Valley of *Stura* towards the Middle of the Mountain, there were some Houses in a Place called *Bergemolleto*, which on the 19th of March, in the Morning (there being then a great Deal of Snow) were entirely overwhelmed by two vast Bodies of Snow, that tumbled down from the upper *Alps*. All the Inhabitants were then in their Houses, except one *Joseph Rochia*, a Man of about 50. Two and twenty Persons were buried under this Mass of Snow, which was 60 *English* Feet in Height. Many Men, were ordered to give them Assistance; but were not able to do them the least Service. After five Days, *Joseph Rochia*, got upon the Snow, (with his Son, and two Brothers of his wife) to try if they could find the Place under which his House and Stable were buried; but they could not. However the Month of April proving very hot, and the Snow beginning to melt, this unfortunate Man was again encouraged to use his best Endeavour. On the 24th, the Snow was greatly diminished, and he conceived Hopes of finding out his House by breaking the Ice. He thrust down a long Pole, but the Evening coming on, he proceeded no farther. His Wife's Brother dreamed the same Night, that his Sister was still alive, and beg'd him to help her. He rose early in the Morning, told his Dream to *Joseph* and his Neighbours, and went with them to work upon the Snow, where they made another opening, which led them to the House, they search-

ed.

ed for: but finding no dead Bodies in its Ruins, they sought for the Stable which was about 240 *English* Feet distant, and having found it, they heard a Cry of "Help my dear Brother." Being greatly surprized as well as encouraged by these Words, they laboured till they had made a large opening, thro' which the Brother went down, where the Sister with a feeble Voice told him "I have trusted always in God and you, that you would not forsake me." The other Brother and the Husband then went down, and found still alive the Wife about 45, the Sister about 35, and a Daughter about 13 Years of Age. These they raised on their Shoulders to Men above, who pulled them up, and carried them to a neighbouring House; they were unable to walk, and so wasted, that they appeared like mere Shadows.

Some Days after the Intendant came to see them, and they gave him the Account that follows. In the Morning of the 19th of March, we were in the Stable, with a Boy six Years old, and a Girl about 13. In the same Stable were six Goats, one of which had brought forth two dead Kids the Evening before; there were also an Ass and five or six Fowls. We were sheltering ourselves in a Corner of the Stable, till the Church-bell should ring, intending to attend the Service. The Wife wanting to go out of the Stable to kindle a Fire for her Husband, then clearing away from the Top of the House, she perceived a Mass of Snow breaking down towards the East, on which she went back into the Stable, shut the Door and told her Sister of it. In less than three Minutes they heard the Roof break over their Heads, and also Part of the Ceiling of the Stable. The Sister advised her to get into the Rack and Manger, which she did very carefully. The Ass was tied to the Manger, but got loose by struggling, and though it did not break the Manger it threw down the little Vessel which the Sister took up, and used afterwards to hold the melted Snow, which served them for Drink. Very fortunately the Manger was under the

main Prop of the Stable, and thereby resisted the Weight of the Snow. Their first Care was to know what they had to eat; the Sister had in her Pockets fifteen Chestnuts: The Children said they had breakfasted, and should want no more that Day. They remembered there were 30 or 40 Loaves in a Place near the Stable, and endeavoured to get at them but were not able, by Reason of the Snow. On this they called out for Help as loudly as they could, but were heard by nobody. The Sister came again to the Manger after she had tried in vain to come at the Loaves, gave two Chestnuts to the Wife, and eat two herself, and they drank some Snow-water. All this While the Als continued kicking, and the Goats bleated very much, but soon after they heard no more of them. Two of the Goats however were left alive, and were near the Manger, they felt them carefully, and knew by so doing that one of them was big, and would kid about the Middle of April; the other gave Milk, wherewith they preserved their Lives.

The Women affirmed, that during all the Time they were buried, they saw not one Ray of Light; nevertheless, for about twenty Days, they had some Notion of Night and Day; for when the Fowls crowed, they imagined it was break of Day, but at last the Fowls died. The second Day, being very hungry, they eat all the remaining Chestnuts, and drank what Milk the Milk-goat yielded, which for the first Days was near two Pounds a Day, but the Quantity decreased gradually. The third Day, being very hungry, they again endeavoured to get to the Place where the Loaves were, but they could not penetrate to it. They then resolved to take all possible Care to feed the Goats, as very fortunately over the ceiling of the Stable, and just above the Manger, there was an Hay-loft with a Hole, through which the Hay was put down into the Rack. This Opening was near the Sister, who pulled down the Hay and gave it to the Goats, as long as she could reach it, which when she could no longer do, the Goats

climbed

climbed upon her Shoulders, and reached it themselves. On the sixth Day the Boy sickened, complaining of violent Pains in the Stomach for six Days, on the last of which he desired his Mother, who all this Time had held him in her Lap, to lay him at his Length in the Manger. She did so, and taking him by the Hand felt it was very cold: She then put her Hand to his Mouth, and finding it likewise very cold she gave him a little Milk; the Boy then cried, "O my Father in the Snow! Oh! Father! Father!" and then expired.

The Mother told the Sister, the Boy was dead, and then laid him in the Manger, where the Sister was. In the mean while the Milk given by the Goat diminished daily, and the Fowls being dead, they could no more distinguish Night and Day; but according to their Calculation the Time was near when the other Goat should kid, which as they computed would happen about the Middle of April; at Length they found the Goat was kidding by its Cries, the Sister helped it; they killed the Kid to save the Milk for their own Subsistence. And now they knew it was the Middle of April. Whenever they called this Goat it would come and lick their Faces and Hands, and gave them every Day two Pounds of Milk, for which they still bear a great Affection to it.

During all this Time, Hunger gave them but very little Uneasiness, except on the first five or six Days, their greatest Pain was from the extreme Coldness of the melted Snow-water, which fell on them; from the Stench of the dead Ass, dead Goat, and Fowls; but more than all, from the uneasy Posture they were obliged to continue in; for though the Place in which they were buried was twelve *English* Feet long, eight wide, and five high, the Manger in which they sat squatting, against the Wall, was no more than three Feet four Inches broad,

Lima in *Peru* contains about 60000 Persons. In 1747 an Earthquake laid three Fourths of the City Level with the Ground. *Callao*, the Port of *Lima*, containing three or 4000 Inhabitants, was totally destroyed. Only one Man escaped, and that by a very singular Providence. He was going to strike the Flag on the Fort, that overlooked the Harbour, when he saw the Sea retire to a considerable Distance, and then return, swelling Mountain high. The Inhabitants ran from their Houses, in the utmost Degree of Terror and Confusion. A cry for Mercy arose from all Parts: And immediately all was silent, the Sea had quite overwhelmed the City, and buried it for ever in its Bosom. But at the same Time it drove a little Boat to the Side of the Fort, into which the Man leaped and was saved.

May we not impute to Earthquakes, those huge Cavities in the Earth, which are found in several Parts of *England*? Such is *Pooles-hole*, about half a Mile from *Buxton*, in *Derbyshire*, said to have been the Refuge of one *Poole*, a noted Robber. It is at the Foot of a Mountain: Its Entrance is low and narrow; but it presently opens, into a broad and lofty Concavity, of above a Mile in Length. The Water dropping from the Roof, congeals into a Kind of Chrystal, and forms a thousand surprizing Figures. Here is also a large, clear Stone, resembling *Alabaster*, which the Queen of *Scots* when here, called *her Pillar*, and it still goes by that Name. Along the Middle a Stream of Water falls among the Rocks, which loudly echoes through the Vault. The most surprizing Thing is, the Height of the Arch, and the spangled Roof resembling Fret-work. And indeed the Drops of Water which petrifying as they fall, form Icicles resembling Chrystal above, and Pyramids hardened into Stone below, have a surprizing Effect from the Light of the Candles: The hanging Drops dazzling the Eyes, as if this mighty Arch was covered with Diamonds.

Elden-hole is a frightful Chasm in the Middle of a Field, fifty or sixty Feet long, and about Twenty broad. But how deep it is, could never be discovered, notwithstanding all the Attempts that have been made. Mr. *Cotton* endeavoured to fathom it with a Line of sixteen hundred Yards; but in vain. Some suppose these to have been Passages, whereby the Waters of the Deluge, returned from the Surface of the Earth to the Great Abyss.

A late ingenious Writer ascribes all Earthquakes to the same Cause, *Electricity*. The Impression, says he, they make on Land and Water, to the greatest Distances is instantaneous. This can only be effected by *Electricity*. In the late Earthquake the Concussion was felt through the Space of an hundred Miles in Length, and forty in Breadth at the same Instant. Now what could throw a Tract of Land, of four thousand square Miles in Surface, into such an Agitation in a Moment? No natural Power is equal to this, but that of *Electricity*, which alone acknowledges no Bounds, neither any sensible Transition of Time. The little Damage done by most Earthquakes, is another Argument, for their being occasioned, by a simple Vibration of the Earth through an electric Shock. This Vibration on the Water, meeting with the solid Bottoms of Ships, occasions that Thump which is felt by them. That this shakes Millions of ordinary Houses, and yet not one of them falls, is a farther Proof, that it is not a Convulsion in the Bowels of the Earth, but an uniform Vibration along its Surface, like what we occasion in a Glass, by rubbing our Finger on the Edge: Which yet may be brought to such a Pitch, as to break the Glass in Pieces, by an electric Repulsion of its Parts.

There can be little Doubt, but some Earthquakes are owing to *Electricity*; but many more are owing to other Causes: Those of *Callao*, *Lima*, *Port-royal*, for Instance, were unquestionably owing to Water: Those in the Neighbourhood of *Etna* and *Vesuvius*,

with those in the *East-Indies*, to Lakes of Fire. The grand Fault is therefore, the ascribing them either to Electricity, or any one Cause, exclusive of the Rest: Whereas some are owing to each of these Causes: Some to several of them acting conjointly.

V. II. P. 73. One who accurately observed it, gives the following particular Account of a *burning Well*.

"In the latter End of February, I went to see a Spring in the Road, which leads from *Wigan* to *War-mington*. When we came to it, and applied a lighted Candle to the Surface of the Water, there was suddenly a large and vigorous Flame produced. But having filled a Cup with Water at the flaming Place, and held a lighted Candle to it, it went out. Yet the Water at that Place boiled like Water over a Fire; though when I put my Hand into it, it did not feel so much as warm. This boiling seems to proceed from some sulphureous Fumes, the Spring being not above 40 Yards from a Coal-pit, and all the Country for many Miles round being underlaid with Coal.

When the Water was drained away, I applied the Candle to the Surface of the Earth where the Water burned before. The Fumes took Fire and burnt very bright and vigorous, the Flame ascending a Foot and an half from the Ground: And the Basis of it was as broad as a Man's Hat at the Brims. It was not discoloured like that of Sulphur, nor had any Scent. I ordered a Bucket of Water to be poured on the Fire, and it was immediately quenched."

There is a Spring of the same Kind at *Brosely*, near *Wenlock* in the County of *Salop*. It was discovered in June 1711, by a terrible Noise in the Night, which awakened several People in their Beds, who desiring to know what it was, rose up, and coming to a boggy Place under a little Hill about 100 Yards from the *Severn*, perceived a mighty rumbling and shaking of
the

the Earth, and a little Water boiling up through the Grass. When they dug up some of the Earth, the Water flew up to a great Height, and a Candle that was in their Hand set on Fire. There is now (viz. in 1711) an Iron Cistern round the Spring, with a Cover, having a Hole in the Middle of it. If you put a lighted Candle to the Hole, the Water takes Fire, and burns like Spirits of Wine. It burns as long as you keep the Air from it; but if you take up the Cover it goes out. The Heat of this Fire exceeds that of common Fire. Some People after they have set the Water on Fire, have put a Kettle of Water over the Cistern, with a Joint of Meat in it. It was boiled much sooner than it could be, by any artificial Fire. If you put Wood, or even green Boughs upon it, it presently consumes them to Ashes. The Water of itself feels as cold as any common Water. Nay, if you put your Hand into it as soon as the Fire is out, it feels as cold as if there had been no Fire near it. But it still continues boiling up, with a considerable Noise.

But this Well was lost for many Years. The poor Man in whose Land it was, missing the Profit he used to have by shewing it, used all his Endeavours to find it again, and in May 1744, hearing a rumbling Noise under the Ground, a little nearer the River than the former Well was, he lighted upon it again. For five or six Feet deep, it is above six Feet wide. Within this is a smaller Hole, of like Depth dug in the Clay, in the Bottom of which is a cylindric earthen Vessel, four or five Inches Diameter, having the Bottom taken off, and the Sides fast in the Clay. Within the Pot is brown Water, thick as Puddle, continually forced up with a violent Motion and a hollow Noise, raising and falling by turns, five or six Inches. Upon putting a Candle at the End of a Stick, within a Quarter of a Yard, it took Fire, darting and flashing in a violent Manner, about half a Yard high, much like Spirits

in a Lamp, but with a greater Agitation. The Man said, that it had made a Tea Kettle boil in nine Minutes, and that it would burn 48 Hours without any sensible Diminution. It was extinguish'd by putting a wet Mop upon it. And still the Water felt very cold. The Well lies about thirty Yards from the *Severn*, which in that Place, and for some Miles above and below, runs in a Vale full an hundred Yards perpendicular below the Level of the Country on either Side.

There is a Fire of the same Kind at *Pietra Mala*, a Village on the *Apennines*. The Flame is extremely bright, covers a Surface of three Yards by two, and usually rises about four Feet. After great Rains or Snows, the whole bare Patch, about nine Yards diameter, flames. The Gravel, out of which it rises, at a very little Depth, is quite cold. There are four of these Fires in the Neighbourhood : The Middle of the Ground whence one of them rises, is a little hollowed, and has in it a Puddle of Water, thro' which there are strong Ebullitions of Air. This Air will not take Fire ; but that which rises through the wet and cold Gravel, flames briskly.

A Fire of a still stranger Nature appeared in *Wales*, about Christmas, 1693. A fiery Vapour came from the Sea, and moved up and down for many Weeks. It set on Fire sixteen Ricks of Hay at *Harlech*, in *Merionethshire*, and two Barns, and annoy'd the Country, as well by poisoning the Grass, as firing the Hay. It was a blue, weak Flame, and did no Harm to the Men who tried to save the Hay, though they ventured even to touch it. An intelligent Person who lived near *Harlech*, informed his Friend some Time after, " The Fire still continues there. It comes over a Part of the Sea, from a masy Place in *Carnarvonshire*, eight or nine Miles off. The Grass over which it moves, kills all Manner of Cattle that feed upon it, Sheep, Goat, Swine, Cows and Horses.

But

But what is very remarkable is, that any great Noise, as beating a Drum or sounding an Horn, effectually repells it from any House, or Barn, or Stack of Hay."

P. 76. Perhaps a larger Account of so remarkable an Incident will not be unacceptable to the curious Reader.

The Countess, *Cornelia Bandi*, in the 62d Year of her Age, was all Day, as well as usual. When she was in Bed, she passed two or three Hours in talking with her Maid; then she fell asleep. The Maid going into her Chamber in the Morning, saw four Feet distant from the Bed, an Heap of Ashes, and two Legs with the Stockings on. Between them was Part of the Head; but the Brains, half the Scull, and the whole Chin were burnt to Ashes. The Ashes when taken up, left in the Hand a greasy and stinking Moisture. The Bed received no Damage; the Cloaths were raised on one Side, as by a Person rising from it.

Doubtless the Fire was kindled within her by the Juices and Fermentations in the Stomach, by the many combustible Matters which abound in living Bodies, for the Uses of Life. These in Sleep, by a full Respiration, are put into a stronger Motion, and consequently are more apt to take Fire.

Borelli observes, That such Accidents often happened, to great Drinkers of Wine and Brandy. Such Flames would frequently rise in us, if the natural Moisture did not prevent.

Undoubtedly she was burnt standing; hence her Skull was fallen between her Legs, and the back Part of her Head was damaged more than the Forepart, partly because of her Hair, partly because in the Face, there were many Places, out of which the Flames might pass.

An Instance of the same Kind occurred at Christ Church in *Hampshire*, on June 26, 1613. One *John*

Hitchell, a Carpenter of that Parish, having ended his Day's work, came Home and went to Rest with his Wife. Her Mother being frightened in her Sleep, called to them for Help. None answering, she started up and waked her Daughter, who found her Husband dead by her Side. She dragged him out of the Bed into the Street; but the Fire then forced her to let him go. He lay burning there for three Days. Not that there was any Appearance of Fire outwardly, but only a Smoke ascending from his Carcase, till it was burnt to Ashes: Except only a small Part of his Bones, which were cast into a Pit.

Grace Pett, was a Fisherman's Wife, of the Parish of *St. Clement's*, in *Ipswich*, about Sixty. She had a Custom for several Years of going down Stairs every Night, after she was undrest, to smoke a Pipe. Her Daughter, who lay with her, did not miss her till the Morning, April 10, 1744, when going down Stairs, she found her Mother's Body, extended over the Hearth, with her Legs on the Deal Floor, and appearing like a Block of Wood, burning with a glowing Fire without Flame. The Neighbours coming in at her Cries, found the Trunk of the Body in a Manner burnt to Ashes. It then appeared like an Heap of Charcoal, covered with white Ashes, the Head, Arms, Legs and Thighs were also much burnt. A Child's Cloaths on one Side of her, and a Paper-screen on the other, were untouched. The Deal Floor also, on which her Legs lay, was neither singed, nor discoloured.

Almost as strange, tho' not attended with any ill Consequence, was the following Incident. In November, *Mrs. Susanna Sewall*, Wife to *Major Sewall*, in *New England*, observed a strange Flashing of Sparks in all the Apparel she put off, which continued till Candlemas. In the Company of many Persons, she sent for several Parts of her Wearing Apparel, and when they were shaken, Sparks flew out, making a

Noise,

Noise, much like Bay-leaves thrown into the Fire. One Spark light on Major Sewall's Thumb-nail, without any Heat, and continued at least a Minute before it went out. They caused Mrs. Sewall one Day to put on her Sister Digge's Petticoat; and when she put it off at Night, it sparkled as her own used to do.

P. 76. There are few Phænomena relative to Glass more hard to be accounted, than that of the Bologna Bottle, so called because it was first discovered at Bologna. If you let these Bottles fall from some Height on a Brick-floor, they will not be broken; but drop into them some little hard Body, and they will burst in Pieces. I took one of these, says Dr. I. which held near a Pint, and let it fall five Feet and an half on a Brick-floor, and it was not broken. I dropt into it a Bit of Flint, weighing eleven Grains, and immediately it burst in Pieces.

I dropt into another Bottle a Ball of Lead, weighing 140 Grains, into a Third a Piece of Brass, weighing 300 Grains, when neither of them was broken.

These Glasses only differ from common Phials in this, they have not cooled gradually in what is called, the *nealing Furnace*, but are exposed to the open Air as soon as formed. They resist hard Blows from without. I have given to some violent Strokes with a Mallet, and they have not broke. They likewise do not break, though several heavy Bodies be dropt into them. I have dropt into them from the Height of three Feet, Musket-balls, and Pieces of Iron, Brass, Gold, without any Effect; but when I dropt into it from the Height of three Inches, a Shiver of Flint no bigger than a small Pea, in about two Seconds the Glass flew. Having tried the Experiment on several others with the same Piece of Flint, most of them broke in the Moment of the Stroke, the rest one or two Seconds after it.

I let fall into several Glasses a Flint of half the Size, and they flew in like Manner. I let fall into one, a Flint no larger than a Grain of Sand; shook the Glass, and set it down. I did the same with four others. In about half an Hour, one of them flew, and the other four soon after.

I let fall into one a Sapphire set in a Ring: And though the Bottom of the Glass was near an Inch thick, the Sapphire passed through it as through a Spider's Webb. The Glass flew all Ways, and the Ring remained on the Table just where it fell.

A Bit of China, half a Line thick and two Lines broad, broke several Glasses; so did a Bit of Glass of the same Size, so did Diamonds also. And a very small Piece of tempered Steel, broke all the Glasses into which I dropped it.

Some large, hollow Cups made at *Worcester* of common Green Glass, much larger than the others, and some of them above three Inches thick at the Bottom, though they were not affected by a Musket-ball dropt from the Height of near three Feet, were instantly broken with a Shiver of Flint, weighing but two Grains.

Equally strange are the Phenomena of the *Glass-drop*. The Make of this Drop is as simple, as its Explanation is difficult. They take up a small Quantity of melted Glass on the Top of an Iron Rod, and let it drop into a Pail of Water. When it does not break in the Operation, it forms the *Glass-drop*. This is of such Firmness, that it bears smart Blows of an Hammer without breaking. But if you break but the Tip of the small End, the Whole shatters into Powder. This shattering is attended with a loud Report, and the Powder scatters all around. If the Experiment be made in the Air-pump, the Drop bursts more impetuously, and the Dust is finer than when it bursts in the open Air. This is the plain Matter of Fact. I do not undertake to account for it.

Near the Bay of *Acre* in *Palestine* runs a little River, now called *Kardanah*, supposed to be the antient *Belus*, famous for its Sand, much used in making *Glass*, and said to have given Rise to the Invention of it. The *Sidonians* are reported to have made this Discovery, from the following Accident. Some travelling having reared an *Hearth* on the Sand of this River with large Pieces of *Nitre*, and set some Fern on Fire under a Kettle, in order to boil their *Visuals*, perceived the Sand and *Nitre* to melt and incorporate with the Fern-ashes, and presently after, to run in a transparent Stream, which hardened as it cooled. From hence the Hint of making *Glass* was taken, which was gradually improved to its perfect Use and Beauty.

P. 84. Many have imagined, that the animal Fluids are furnished with *Air* by the Lungs only. But undoubtedly they are also supplied therewith, by Way of the chyliferous Canals: And that in no small Quantity. For the *Air*, like all other animal Fluids, requires to be perpetually renewed accordingly old Particles fly off every Moment, and new ones succeed in their Place.

It may be demonstrated, that *Urine* contains much *Air*. Doubtless so does the perspirable Matter: Which being the lightest of all animal Fluids, is the chief Vehicle of the effete and useless *Air*.

That fixt *Air* is a cementing Principle appears (to omit others) from that well known Experiment. Quicklime dissolves flesh, by extracting and imbibing the fixt *Air*, which it contained. But while the *Flesh* falls in Pieces from the Loss of the Principle, the *Lime* grows solid by having it restored.

That it contributes also to the Dissolution of Bodies appears hence. During the Progress of *Putrefaction*, a volatile Matter flies continually from the putrifying Substance. And this is no other than *Air*, which is now extricated and thrown off from a fixt and unelastic State, but immediately returns to it again, on meeting with a proper Recipient.

The preserving Bodies from *Putrefaction*, depends almost

most in every Instance, on restraining the Flight of the fixt Air. For as this cements their constituent Parts, so Putrefaction which is the Disunion of them, cannot take Place while this Remains.

And this Air both corrects and prevents putrid Acrimony in the animal Fluid. Hence any Food which does not contain a due Proportion of it, is found to promote Putrefaction: As do all damaged Vegetables, which being incapable of Fermentation, are incapable of producing the due Quantity of Air.

But there is an amazing Difference between the *fixt*, and the *common* Air, with Regard to their Effects upon animal Bodies. The *fixt* Air even when set free, and in a State of perfect Elasticity, whether it be during the first Stage of Fermentation by Fire, by Effervescence, or by Putrefaction; if it be received into the Lungs of any Animal, causes instant Death. But the same Air, when received into the Stomach, whether thrown off by effervescent Mixtures in Medicine or extricated from the Food by natural Fermentation; in the first Instance often operates like a Charm, in restraining Vomitings; and in the second is absolutely needful, for the support of Life and Health.

With regard to the *common* Air, on the contrary, no Animal can live long without taking large Quantities of it into the Lungs. Yet if a small Portion of it be forced into the Blood-vessels of any Animal, Death presently ensues.

So that these two Species of Air have quite different Provinces, with Respect to animal Life. The first *common* Air, must mix wholly with the Blood; The second only communicates some subtle Matter to it. Perhaps electric Fire, which we know is connected with every Particle of common Air.

Oil of Vitriol when exposed to the Air, continually increases in Weight. Let a Phial of this stand unstopped, and it will be constantly running over. Perhaps the Cause of this odd Phenomenon is, the Moisture contained in the Air, which this Liquor, a potential

tential Fire, imbibes as greedily, as actual Fire does Nitre.

P. 87. After Pieces.

At the Height of forty-one Miles, the Air is so rarified, as to take up three thousand Times the Space it does here. At fifty-three Miles high, it would be expanded thirty thousand Times as much as it is here. But it is probable, the utmost Power of its Spring, cannot produce so great an Expansion: And that no Part of the Atmosphere extends above forty-five Miles from the Surface of the Earth.

At that Distance, (as was observed) it is expanded into three thousand Times the Space it occupies here. And we have seen it condensed into the sixteenth Part of the same Space. It seems then, that the Air is capable of being condensed into the hundred and eighty thousandth Part of the Space it would take up when free from Pressure. But what Texture must it be of, to make it capable of this immense Expansion and Contraction? How imperfectly is this accounted for, by comparing it to Wool, Cotton, and the like elastic Bodies?

C H A P III.

Of Meteors.

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| 1. How Vapours ascend. | 13. All Diamonds emit |
| 2. Experiments on Dew. | Light. |
| 3. What causes the Drops | 14. Parallel between lumi- |
| of Rain to be round? | nous Wood and live |
| 4. Salt Rain. | Coal. |
| 5. Of Snow. | 15. ——— between Electri- |
| 6. An uncommon Meteor. | city, Light and Mag- |
| 7. Another. | netism. |
| 8. A fatal Damp. | 16. Ether of Plants. |
| 9. An unusual Murrain. | 17. Of West-Indian Hurri- |
| 10. Ignis faturi. | cans. |
| 11. Luminous Fish and Flesh. | 18. Of Water-spouts. |
| 12. Observations on Phos- | 19. Of Storms on the Fether. |
| phorus. | |

P. 89. **T**O explain the Ascent of *Watery Vapours*, it may be observed, that the Parts of Water being so small and moveable, are easily separated from one another. And when they are so divided into small Parcels, as to become about eight hundred Times lighter than common Water, they are as light as the Air, and will by every successive Degree of Separation, rise in the Air in Proportion to their Lightness, the heavier Air forcing the rarified Fluid to ascend into the Atmosphere, till it finds a Place where it rests in Equilibrium among bodies of equal Lightness to itself. This Separation or Comminution (if I may so call it) of Water into small Parcels, may be performed either by Collision against harder and more compact Bodies, or by heat. The first we often see performed at the Bottom of Cascades, where the Water that falls but a few Fathoms, shall rise in a Mist from the Bottom where it is broke; and there are Instances of Clouds rising from the Fall of Waters, which may be seen five Miles off. Collision will therefore excite Vapours; but what is more constantly producing this Effect in every Part of the Universe, is Heat; whether from the Sun, which is always busy this Way, or from artificial Ignition, or that generally invisible elemental Fire which is distributed through all Matter. It has been by many Naturalists imagined, that heat, raises Vapours by extending the Air in the Pores of Water, and forming gradually a thin Film or Bubble of Water, of such Dimensions that it becomes greatly lighter than the same Space of common Air, and therefore rises above it; but this Supposition is not tenable; for it is observed, that Steam will rise in the Receiver of an Air Pump, where, tho' there remains some Air, there is not enough to constitute such a Process. It may here also be added that Earth, Stones, and Metals may be raised into the Atmosphere, altho' their Parts will not form bubbles as those of Water will. As this generally allow'd Supposition cannot be supported, so neither is it necessary for us to consider

consider in this Case, any other than the Divisibility of Water, and the insinuating and disperseive Qualities of Fire. Fire, we see, separates more or less the Parts of all Bodies, whether fluid or solid, and makes them rise in the Air; and it does no more to Water: It separates it, into such small Portions, that the Air is more ponderous than the Steam, and of Consequence remains nearer the Earth, by its superior Gravitation.

P: 90. A Pewter Plate placed all Night in the open Air, receives no Dew on its *upper-side*, but the *under-side* is covered with it. On the contrary, place a China Plate near it, and the upper-side of it is quite wet, but the under-side is quite dry. So one receives the Dew only on the upper, the other only on the under Surface!

Mr. *Kershaw* has observed, that Dew newly gathered and strained, is not very clear, but of a yellowish Colour:

That when he endeavoured to putrify it, by various Degrees of Heat, he quite failed of his Intention: For Heat rather clarified and preserved it sweet, than caused any Putrefaction;

That after it had been exposed to the Sun, corked up for a whole Summer, there was no other Change than that much green Stuff (such as we see in standing Water) floated on the Top.

That after it had been exposed to the Sun many Weeks in an open Glass, it was full of little Insects, like Tadpoles, which in a while dropt their Skins, and became Gnats:

That vapouring away, great Quantities of this Dew, he procured two Pounds of greyish Earth, which lay in Leaves, one above another, like brown Paper, but very friable.

Lastly, that by often calcining and filtering this Earth, he extracted two Ounces of a fine, small, white Salt, which much resembled Rock Salt, when it was viewed thro' a Microscope.

By what Power are the *Drops of Rain* so equally dispersed? This may be shewn by an easy Experiment. Put a Quantity of Brass-dust into an electric Phial. When this is charged, invert it, and throw some of the Dust out. This will be spread over a flat Surface, with exact Uniformity, and will fall just like Rain or Snow. 'Tis highly probable, this is the Case with the Clouds. Being highly electrified, they of Course spread their Contents equally, over the Surface of the Earth.

P. 91. A few Years, during a violent Storm of Wind, much Rain fell in the western Part of Cornwall, which was mere Sea-water, as salt as that which was just taken out of the Sea. It seemed to have been drawn out of the Sea, and thrown upon the Land in the same Hour: So that there was no Time for that wonderful Operation of Nature, whereby the Water that ascends in Clouds, is freed from its salt and bituminous Particles, before it falls to the Earth.

Why is Snow, tho' it seems to be soft, truly hard? Because it is true Ice. It seems soft, because at the first Touch of the Finger on its sharp Edges or Points, they melt. Otherwise they would pierce the Finger, just as so many Lancets.

But why, tho' it be true Ice, which is an hard and dense Body, is it so very light? Because of the extreme Thinness of each Icicle, in Comparison of its Breadth. So Gold, the most ponderous of all Bodies, when beaten into Leaves, rides upon the Air.

Why is it white? Because its Parts, tho' singly transparent, yet must appear white when mixt together: As do the Parts of Froth, of powdered Glass, and other transparent Bodies, whether soft or hard.

P. 95. Of what Kind was that *Meteor* which appeared March 21, 1678? Two Hours after Sun-set, it came over the Adriatic Sea, from E. N. E. to W. S. W. and crossed over all Italy, being nearly verticle

to *Rimini* on the one Side, and *Leghorn* on the other. It was at least thirty-eight Miles high. In all Places near its Course, it made a hissing Noise, like a Sky-rocket. Having past *Leghorn*, it gave a Sound like that of a large Cannon, and quickly after like a Cart running over Stones. It was computed to move 160 Miles in a Minute, which is above ten Times as swift as the diurnal Motion of the Earth. Its smaller Diameter was judged to be above half a Mile. No wonder then that so large a Body, moving with such incredible Swiftnes thro' the Air, tho' so much rarefied, should cause that hissing Noise. 'Tis much harder to conceive, how such an Impetus could be impressed upon it? How this Impetus should be determined, in a Direction so nearly parallel to the Horizon? And what Sort of Substance it must be, that could be so impelled and ignited at the same Time? Whatever it was, it sunk, and was extinguished in the *Tyrrhene Sea*, to the W. S. W. of *Leghorn*. The great Noise was heard, on its Immersion into the Water; the Rattlings sound upon its quenching.

On Thursday, March 19, 1719, there appeared at *London*, about eight at Night, a sudden great Light, moving after the Manner, but more slowly than a falling Star, in a direct Line, a little beyond, and withall below *Orien's-Belt*, then in the South West. In its Way it turned tapering upward, and at last spherical, near as big as the Full Moon. It was whitish, with an Eye of blue, as bright as the Sun in a clear Day. It seemed in half a Minute to move twenty Degrees, and to go out, as much above the Horizon. There remained after it for more than a Minute, a Track of a reddish Colour, such as that of red-hot Iron; and Sparks seemed to issue from it, such as come from red-hot Iron beaten upon an Anvil.

Within Doors the Candles gave no Light; and without, not only the Stars disappeared, but the Moon, nine Days old, tho' the Sky was clear, and

He was then near the Meridian: So that for some Seconds, we had perfect Day. It's Height was seventy-three Miles and a half. Hence it might be seen in all Places, which were not distant from it more than two Hundred and twenty Leagues. Accordingly it was seen at the same Instant, over *Spain, France, Great-Britain, Ireland, Holland,* and the hither Parts of *Germany*.

P. 96. An Instance of the fatal Nature of foul Air happened at *Boston* in *New England*. Mr. *Adams* and his Servant being employed to repair a Pump, uncovered the Well, and Mr. *Adams* went down by a Rope; but he had not gone six Feet, before he dropt suddenly without speaking a Word, to the upper Part of the Joint of the Pump, where being supported about a Minute, and breathing very short, he then fell to the Bottom, without any Signs of Life. His Servant hastily went down, to help his Master; but at the same Distance from the Top, was struck, and without discovering any Signs of Distress, fell to the Bottom. The Workmen prepared a Third, with a Tackle about his Waste. On his Descent, he was quickly Speechless and senseless. Tho' he made no Sign, they drew him up. He was the very Picture of Death, but by the Use of proper Means recovered. He remembered nothing of what had passed. The other Bodies when taken up, had all the Marks of a violent Death.

May we ascribe to a Kind of Damp, a Sort of Murrain, which appeared in *Italy*, and made great Havock among the Cattle? It spread itself in the Form of a blue Mist, over those Pastures where they grazed: So that whole Herds came home sick, and most of them died in 24 Hours. Many who went among them, were infected, and died in the same Manner. Some imputed this Contagion to noxious Vapours, thrown out of the Earth, by Earthquakes preceeding. It passed thro' *Germany* to *Poland*, going without Intermission, eleven or twelve Miles in twenty-four Hours, and

and suffering no Cattle in its Way to escape, whether within Doors or without. Hence others imagined it was owing to some volatile Insect, which was able to make but short Flights.

P. 97. In all the Territory of *Bologna*, the fiery Appearances, vulgarly called Will with the Wisp, are common. There are some Places where one may be almost sure of them, every dark Night, as near the Bridge *Della Salcarata*, and in the Fields of *Bagnara*. Both these are large: Some Times equal to the Light of a Faggot, rarely less than that of a Link. That at *Bagnara* not long since kept a Gentleman company for a Mile moving just before him, and casting a stronger Light on the Road, than the Link he had with him.

All of them resemble a Flame, and are continually in Motion, but the Motion is various and uncertain. In Winter, when the Ground is covered with Snow, they are most frequent of all. Nor does Rain hinder them: Nay, in wet Weather they give the strongest Light: Wind also does not disturb them. As they are not hindered by wet, and set nothing on fire, though ever so combustible, may it not reasonably be supposed, that they have some Resemblance to that Kind of *Phosphorus*, which shines indeed in the Dark, yet does not burn like common Fire?

The following Experiments shew a little more of the Nature of this strange Substance.

Salt of *Phosphorus*, kept in a vitrifying Hear, at last runs into perfect Glass. What a wonderful Subject is this? And how surprising it is, that so inflammable a Body should become Glass! Here then is a perfect Transmutation of Bodies: The *Phosphorus* being transmuted into a transparent Glass of a bluish green, coming nearer the Hardness of a Diamond, than any other Glass whatever. And the Glass is in the very same Quantity with the *Phosphorus*, which produces it Ounce for an Ounce.

Another odd Circumstance relating to Phosphorous is, cut it small, or scrape it with a Knife, and lay it on a Glas Dish in moist Air. In a Week it resolved into a Liquid, near eighty-times its original Weight. This Liquid is the same in all Respects, with that which comes from the sublimed Flowers by Deflagation. And this may be turned into the same Glas with the original Phosphorus.

P. 99. Some boiled *Mackrel* having been left in the Water for pickle, the Cook a Day or two after, stirring the Water, found it become very luminous. Wherever the Drops of it fell on the Ground they shined. The next day we repeated the Trial. The Water still stirred, gave no light; but when gently stirred by the Hand, it shone bright; and by a brisk Motion it seemed to flame. The Fish shone, as well from the Inside as the out. The Fish were not yet either fetid or insipid. When fetid, they did not shine at all.

The chief Circumstances which Mr. B. noted concerning *luminous Flesh* were, 1. It was a Neck of Veal, bought some Days before; 2. In this about twenty Places shone, tho' not alike: 3. Most of these were as big as the Nail of a Man's Finger, and irregularly shaped: 4. The Parts which shone most were the gristly, or the bruised Parts of the Bones: 5. Some of these were so bright, that holding a printed Paper to them, I could read several Letters: 6. One could not discern in any of them the least Degree of Heat, neither of Putrefaction: 7. One of these being put into a Cup of cold Water, the Light continued the same.

Not only Water, Fish and Flesh, but some Sort of Wood will shine as bright as a burning Coal. And herein they agree, 1. Both have Light in themselves: 2. Both need the Air, to make them continue shining: 3. Both having lost their Light, by being deprived of Air, recover it, when fresh Air is let in: 4. Both are easily quenched by Water, and 5. Neither of them is affected by the Coldness of the Air.

But

But herein they differ: 1. The Light of a Coal is put out by Compression: That of Wood is not: 2. The Coal is quite extinguished by withdrawing the Air: That of the Wood is only eclipsed: Let the Air in again within half an Hour, and it immediately recovers: 3. A Coal put into a small, close Glass, will not burn many Minutes: A Piece of Wood will shine many Days: 4. A burning Coal emits much Smoke: Shining Wood, none at all.

P. 99. Accurate Observers have found, that any *Diamond*, by an easy Friction in the Dark, by the Finger or a Woollen Cloth, appears in its whole Body to be luminous: And if it has been rubbed a good while, it will keep its Light for a little Time. If when the Sun is set, one hold up a Piece of Flannel, stretched tight between both Hands at a little Distance, and another rubs the Diamond swiftly and strongly on the other Side of it, the Light to the Eye of him that holds the Cloth, seems much more pleasant and perfect. What is more surprizing is, that a Diamond exposed to the open Air, in view of the Sky, (even without being in the Sunshine) gives nearly the same Light of itself without rubbing, as when rubbed in a dark Room. But if you hold your Hand or any Thing else over it, to hinder its Communication with the Sky, let it lie ever so long in the open Air, yet it will give no Light.

A well-polished Piece of *Amber*, will yield Light, if rubbed in the Dark. And if it be drawn swiftly thro' a Woollen Cloth, very many little Cracklings are heard, and each produces a little Flash of Light. If drawn gently, it produces a Light, but no crackling. Are not most of these Circumstances easily accounted for on the Principles of Electricity?

P. 111. Prop. 1. *Electricity* in common with *Magnetism* counteracts, and in light Substances overcomes the

the Force of Gravity. Like that, it exerts its Force in *vacuo*, as powerfully as in the open Air. And this Force extends to a considerable Distance, thro' various Substances of different Textures and Densities.

Prop. 2. In common with *Light*, Electricity pervades Glass; but it suffers no Refraction. Its Direction is still in Right Lines, and that through Glasses of different Forms, included one within the other, and large Spaces left between them.

Indeed the electric Attraction through Glass is much more powerful, when the Glass is made warm: Because warm Glass does not condense the Water from the Air, which makes the Glass a Conductor of Electricity: And also because as Heat enlarges the Dimensions of all known Bodies, and consequently makes their constituent Parts recede from each other, the electric Effluvia find a more easy Passage thro' the Pores.

Prop. 3. Electricity in common with Light, when its Forces are collected, produces Fire and Flame.

That the electric Matter is far more subtle than Air appears, from its passing thro' those Bodies which Air cannot penetrate, Glass in particular. And that it is elastic, appears from its encreasing the Motion of Fluids, and from its extending itself to a considerable Distance round excited Bodies.

Do not all these Experiments shew, that the electric Matter, is pure, elementary Fire, an original, distinct Principle, formed by the Creator himself? And not, as some have apprehended, mechanically producible from other Bodies?

And may it not be doubted, whether this be not the only *elastic* Body in the Universe? Whether it be not the original Spring, which communicates Elasticity to all other elastic Bodies? To the Air in particular: Which is elastic no longer, when detached from electric Fire, but commences *fixt* and unelastic, and seems to recover its Elasticity, only by recovering that ethereal Fire which had been violently separated from it?

P. 118. Next in Subtlety to this ethereal Fluid, the *Ether of Plants* appears to be. It seems to be destitute of all gross Air. For exhaust this ever so accurately, it remains unmoved, and does not emit any Air-bubbles, which immediately arise in other Liquors. A little of it poured on the Hand, gives a Sense of Cold, equal to that caused by the Contact of Snow. Blow upon it once or twice, and your Hand is dry. It causes an Hissing when poured upon warm Water, as if a Piece of hot Iron were thrown into it. Put a Lump of Sugar which has imbibed a little of it, into a Vessel full of hot Water, the Sugar sinks; but the Ether rushing forth, excites a strong Ebullition. If a Spoonful of it be poured into a Copper-pot, full of boiling Water; hold a Candle near, and instantly there issues a great Flash of Lightning. Hence it appears, that this Ether, is both a very fluid Water, and a most subtle Fire: So that if kindled in a Thousand Times the Quantity of cold Water, it burns inextinguishably.

It does not manifest the least Oiliness to the Touch; yet is it the true, natural Dissolvent of all fat Oils and Gums whatever.

It has wonderful Harmony with Gold, even greater than that which is between Gold and Aqua Regia. Dissolve a Piece of Gold in Aqua Regia: On the Solution cold pour half an Ounce of Ether. Shake the Glass and all the Gold will pass into this, and the Aqua Regia robbed of all its Gold, will deposit a white Powder, which soon turning green, is the Copper wherewith the Gold was adulterated. Ether then is the most noble and efficacious Instrument in Chymistry, and Pharmacy, inasmuch as Essences and essential Oils are extracted by it immediately, without the Mediation of Fire, from Woods, Barks, Roots, Herbs, Flowers, Seeds, and the various Parts of Animals.

For

For instance. Take Mint, Sage, Cinnamon or all together, cut and bottle them; pour on them a Spoonful or two of Ether, and after it has stood an Hour in a cool Place, fill up the Bottle with cold Water, and presently you will see the essential Oil, swimming upon the Water. In like Manner, tho' not so immediately, it extracts the purest Gold from any of the baser Minerals. And the Gold thus extracted, is better and sooner purified by this one Operation, than by fusion with Antimony. It is the lightest of all Liquors. Seven Ounces of this fill a Phial, which contains twenty even of Oil of Vitriol. And it is the purest Flame, leaving neither Soot nor Ashes after its Déflagration.

The Heat in the *West-India* Islands would be intolerable, if the Winds rising as the Sun gathers Strength, did not blow from the Sea, so as to temper the Heat even of the Noon-day Sun. On the other Hand, at the Night advances, a Breeze arises from the Land, and blows as from its Center toward the Sea, to all Points of the Compass at once. It is in the rainy Seasons the *Hurricanes* come, and destroy at a Stroke the Labours of many Years. They are sudden and violent Storms of Wind and Rain, attended with a furious swelling of the Sea, and frequently with an Earthquake. As a Prelude, whole Fields of Sugar-cane are instantly whirled into the Air. The strongest Trees of the Forest are torn up by the Roots, and driven about like Stubble. The Windmills are swept away in a Moment; the Copper-Boilers and Stills, of several hundred Weight are wrenched from the Ground, and battered all in Pieces.

P. 110. *Hurricanes* are foreseen at the *Antilles* by a Calm, and then a shifting of Breezes from all Quarters; the Sun sets Blood red, small Clouds fly to and fro with great Rapidity. Sea Birds quit the Air and seek the Shore. Soon after a North Breeze springs up, which comes to the North East. Afterward it is South

South and South-East, and the Air is darkened by a black Cloud.

In the last Hurrican, the Wind stood at North-East, and blew with such Violence, that the largest Trees were torn up the Roots, their Trunks broken to Pieces, and not a Leaf left on those other Trees, which yielded to the Fury of the Winds. The Houses were thrown down, and the Tops of the Sugar-mills, which could not well be thrown down were crushed in Pieces. At the End of an Hurrican we see Lightning, and hear the Noise of Thunder. Then the Wind softens gradually, till all becomes quiet.

When there was a violent Hurrican on *Guadeloupe*, there appeared upon the Island, a thick black Cloud, which seemed on Fire, and gravitating toward the Earth. It occupied a Space of five or six Leagues in Front. Above it the Air was almost clear, there appearing only a Kind of Mist. The whole Force of an Hurrican is lodged, in the very Body of a Cloud, containing Winds, Rain, Lightning and Thunder: Where the Air is compressed, and rolling upon itself, causes the Storms, which nothing can resist. Nor does the Hurrican end, till the Cloud bursts and the Thunder and Lightning come on.

P. 120. It is not universally true, that the Tube of a *Water-spout* touches the Sea, before the Water rises at all, for Water-spouts happen several Ways. Sometimes the Water is seen to boil and raise itself for a considerable Space about a Foot from the Sea, before the Tube touches it. Above this there appears as it were a thick and black Smoke, in the midst of which is a Sort of Pipe, resembling a Tunnel reaching up to the Clouds. At other Times these Tunnels come from the Clouds, and suck up the Water with great Violence. Sometimes these discharge themselves into the Sea, to the unavoidable Destruction of such Ships as are in their Way: Sometimes on the Shore, beating

ing down all they meet with, and raising the Sand and Stones to a prodigious Height.

A very distinct Account of this Kind was given sometime since by an Eye-witness. "We were on the Coast of *Barbary*, when three Water-spouts came down: One of them bigger than three Masts, the other two scarce half as big: All of them were black, as the Cloud from which they fell; all smooth, and smaller at the lower End. Sometimes one became smaller, and then larger again; sometimes it disappeared, and quickly fell down again.

There was always a great boiling and flying up of the Water, like the Appearance of a smoaking Chimney in a calm Day. Sometimes it stood as a Pillar some Yards above the Sea, and then spread itself and scattered like Smoak. One Spout came down to the very Middle of this Pillar, and joined with it. Afterwards it pointed to the Pillar at some Distance, first in a perpendicular, and then in a oblique Line.

It was hard to say, whether this Spout fell first from the Cloud, or the Pillar rose first from the Sea, both appearing opposite to each other, as in the twinkling of an Eye. But in another Place the Water rose up to a great Height, without any Spout pointing to it. Only here, the Water did not rise like a Pillar, but flew scatteringly, and advanced as a moving Bush upon the Surface of the Sea. This proves, that the rising of the Water may begin, before the Spout from the Cloud appears.

All these Spouts, but especially the great one toward the End began to appear like a hollow Canal, along the Middle of which one might distinctly perceive the Sea-water fly up very swiftly: Soon after the Spout broke in the Middle, and disappeared by little and little; the boiling up, yea the Pillar of Sea-water, continuing a considerable Time after.

There is something very uncommon in the *Fetter*, a Lake which parts *East* and *West-Gothland*. It is about

about eighty Miles long and eighteen-broad. Its Water is very clear, and in some Places so deep, as not to be sounded by a Line of 300 Fathom. It is often disturbed by Storms, which sometimes begin so suddenly, that the Surface of the Water is agitated before the least Breath of Wind is perceived. And it is not uncommon, for Boats in one Part of the Lake to be tost by a violent Storm, while others at a small Distance, are in a perfect Calm. Immediately before a Storm, while the Sky is clear, a Noise is perceived in the Lake like Thunder. Of this the Inhabitants of *Visingore*, an Island in the Middle of the Lake, are more sensible than any others. For from that Part of the Island, whence the Wind will blow, they hear a Noise like the firing of Cannon. Whenever this is heard in the East, they expect Hail and Rain to follow. Undoubtedly all these Storms are owing to subterraneous Winds. To these likewise we may attribute the sudden cracking of the Ice upon the Lake in the Spring. This is one Minute strong enough to bear Horses and Sledges, and the next, broken in Pieces. A strange Noise underneath, which precedes the Breach, warns Travellers to make the best of their Way. But those who happen to be at a great Distance from Land are swallowed up, unless they can float upon Shoals of Ice, till they meet with Relief. The violent Under-currents observed in this Lake, are also very surprising. These directly opposing the Winds, give the Fishermen a great deal of Trouble. From these, as well as from its unfathomable Depths, it is supposed to have a Communication under Ground, with another Lake called *Venner*, about forty Miles to the Westward.



Part the Fifth.



*Of the System of the World: Of the
Heavenly Bodies, of the Causes
and Properties of Natural Bodies.*

CHAP. I.

Of the System of the World.

1. *The Orbit of the Planets
continually lessens:*

2. *The Sun stays longer in the*

Northern Signs:

3. *Advantages from the Ro-
tation of the Earth.*

V. II. P. 141.

WHAT a strange Discovery is that, which has been lately communicated by an eminent Professor to the Royal Society? "Having carefully examined, the modern Observations of the Sun, with those of some Centuries past, though I have gone no farther back than the fifteenth Century, yet I have observed that the Motion of the Sun, (or of the Earth) is sensibly accelerated since that Time, so that the Years are shorter

ter

ter now than formerly. The Reason of this is very natural. For if the Earth in its Motion suffers some Resistance, (which cannot be doubted since the Space through which the Planets pass, is full of some subtle Matter, were it no other than Light) this Resistance will gradually bring the Planets nearer and nearer the Sun. And as their Orbits thereby become less, so their periodical Times will be diminished. Thus in Time the Earth would come within the Region of Venus, then of Mercury, where it would necessarily be burnt. Hence it is manifest, that the Planetary System cannot last for ever in its present State: As also that this System must have had a Beginning; otherwise, there must have been a Time when the Earth was at the Distance of Saturn: Consequently, no living Creature could subsist there. This then is a clear Proof, that the World in its present State had a Beginning and must have an End.

We may likewise find Reason to think, from the Action of Jupiter on the Earth, that the Earth's Revolution round its Axis, continually becomes more and more rapid. For the Force of Jupiter so accelerates the Motion of the Earth round the Sun, that the Diminution of the Years would be sensible, if the diurnal Motion had not been accelerated nearly in the same Proportion.

It is another Observation of Astronomers, That the Sun does not shine as long on one Side the Line as on the other; that he stays longer in the six Northern Signs, than in the six Southern: So much longer, as to make no less a Difference, than that of nine Days. How is this? Did the Earth always obvert her Northern Hemisphere to the Sun so much longer than the Southern? Or has she gradually warped so much to one Side, in a Course of near 6000 Years?

Let us consider the Advantages arising to us by the Rotation of the Earth about its own Axis. We are

so made, that once in sixteen or twenty Hours at most, we require a Time for Relaxion. And generally, in healthful People, this Time is pretty equal, between six and eight Hours. The Store-houses of our Spirits will not permit a longer Application than twenty Hours, without Injury to our Constitutions. And about six Hours are required to fill them again:

It was likewise necessary, that the Air should be cool and temperate, during the Time of this Rest; for we generally find those that sleep while the Sun is above the Horizon, the worse for it; the Sun and Heat exhaling the natural Perspirations too violently, and raising too quick a Motion in the Blood. And though we generally perspire more in the Night, yet the Perspiration is more natural and less violent, and more according to the Necessities of our Constitution, in the Night than in the Day. Besides, the Darknes is less subject to Noise and Disturbance than the Day. Now all these Things are wonderfully provided for, by the Rotation of the Earth about its Axis. For thereby we have the Vicissitudes of Day and Night; the Day for spending our Spirits, the Night to recruit them; as also for nourishing the Muscles, Bones, Channels, and other Parts of the Body; for the Business of Nutrition is mostly, if not altogether, performed in the Time of Rest. Likewise, how comfortable and refreshing are the cool Breezes of the Night; and the Trade-winds to those that live under the Equatorial Parts? Without which, Life would both be exceeding short and very grievous.

These Winds, are the necessary Effect of the Rotation of the Earth about its Axis, which under the Line makes the Rays of the Sun direct and equal all the Year round; so that these Parts being constantly under the Sun's Influence, his Heat rarifies one Part of the Air, and the cooler and heavier Part presses upon the hotter, and so makes a continual Wind in his Course from East to West.

Moreover,

Moreover, let us reflect upon our Vegetables which are the Support of Animals; the Sun rarifies and consequently raises the fizy Vegetable Juices at the Roots of the tender Seeds, and thereby forces the folded Branches to expand and enlarge. Now, were the Sun constantly shining upon them, these Juices would not be at Liberty to settle, and consolidate in the fit Places of the Branches; but would be still rising higher and higher, till at last they burst the Canals; whereas by this Vicissitude of Heat and Cold, what is raised in the Day-time, has Time to settle and consolidate in the Night. Its Cold runs the thin Juices into fizy Substances, which the supervinding Heat, by exhaling the watery Parts, hardens and fixes. On the other Hand, had not the Earth moved upon its Axis, but only turned round the Sun in its annual Period, we had not only lost all these Advantages, which are so necessary for both Animals and Vegetables, but had suffered also such Inconveniencies, as neither of these could possibly bear. For near half the Year, we should have been in perpetual Darkness, the Consequence of which would have been, that baleful Damps (by the preceeding Heat, generated and raised) would have fallen, which would have stifled all Animals. Or had they survived that, Snow, Ice and Frost, would not only have locked up all Fluids, but would have freezed the Blood and Spirits in the Channels, of all the Animals we are acquainted with.

Again, in the enlightened half of the Year, we should have had; huge Deluges of Water, from the preceeding Snow which likewise would have produced suffocating Mists. Next all our Ground would have turned into a stiff, sinking Puddle, being in a Manner dissolved by the Snow-water. Then would sultry Heats and a burning Air, have scorched and chapped the Earth, and gall'd the animal Tribes, so that they would have found Rest, neither in Houses nor Dens, till at last, the Blood and Spirits of all the Animals of our Globe, would be quite exhaled, or

by the violent Agitation thereof, they would turn delirious.

Upon all these Accounts, the Rotation of the Earth, about her Axis, is one of the most signal Instances of Divine Wisdom.

P. 145. What Benefits do we receive from our Moon? First, the supplying Light in the Night-time, for at least three Fourths of the Year. Now how comfortable and delightful a Thing this is, Travelers and Voyagers can best tell. Curiosity, Ambition, Luxury, and sometimes Necessity have made it unavoidable, that some Part of Mankind should be travelling by Land or Sea, in the Night Seasons. How pleasant then is it, to have a Light held out from Heaven, to guide our Steps, to direct us in our Course, and to point out to us how our Time wears out?

Secondly, she raises our Tides, twice in twenty-four Hours, which is absolutely necessary towards the Subsistence both of Animals and Vegetables. Every Body knows that a Lake that has no fresh Water running into it, will by the Heat of the Sun in a few Months, and its Stagnation, turn into a stinking, rotten Puddle, sending forth nauseous and poisonous Steams. And though many thousand Rivers daily run into the Sea, yet they are very inconsiderable, in Respect of the vast Ocean of Salt-water; and would by no Means hinder its Stagnation, and consequently its Corruption and stinking. Now suppose the Ocean stagnated, the first Effect would be, all the Places towards the Shores, would be wrought upon by the Sun, and turned to a Memphis. Then it would get farther, till the whole were become more baneful and poisonous than the Lake of Sodom and Gomorrah. Hereby the Fishes would be first destroyed, and afterwards the Plants and Animals: But by this Action of the Moon, the

Waters

Waters are lifted up on a Heap, as it were, and then let fall again, whereby the Waters near the Shores are constantly secured from Stagnation and Corruption, and the beginning Malady stifled. This perpetual Change of new Water on the Shores, keeping any one Portion thereof, from being exposed to the Sun long enough, to have its Mixture corrupted. Now, what a noble Contrivance have we here! By appointing an Attendant to our Earth, all the Animals and Vegetables are preserved from certain destruction. Though indeed to the full Effect of this wise Design, the Salt of the Sea does very much contribute; as there are many saline Rocks and Mountains dispersed over the Foundations of the great Ocean. Besides this, how many Conveniencies for our Navigation in Rivers and Harbours does this ebbing and flowing of the Sea afford? Yet if our Earth had more than one Moon attending it, we should receive more Damage than Advantage, by it; for tho' hereby our Light in the Night might be augmented, yet at their Conjunctions and Oppositions with one another, and with the Sun, we should have Tides that would raise the Waters over too much of our dry Land; and in their Quadratures we should have no Tide at all. Again, if our Moon were bigger or nearer the Earth, or if we had more than one, at any tolerable Distance from us, we should be every now and then in Hazard of being stifled by the noxious Steams arising from the Ocean. From all which it is evident, how wisely our Satellite has been contrived for our Purposes.

P. 148. If the Uses assigned to the *Comets*, by Sir *Isaac Newton*, be real, as they are not improbable, Nature by the supplying the Deficiency and Expences of all Sorts of Fluids necessary to the Earth; I mean not only Light and Heat to the Sun, and watry Vapours to our Atmosphere, but the most subtle,

tle, most useful, and necessary Part (towards Life and Vegetation) to the Air: Then these wandering frightful Bodies, may be justly conceived joining in the Chorus, and loudly resounding the common Hallelujah.

CHAP. II.

Of the Heavenly Bodies.

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| 1. <i>Doubts concerning the Modern Astronomy:</i> | | 3. <i>Mr. Boyle's Remarks on the present State of Philosophy:</i> |
| 2. <i>Mr. Kennedy's Objections to it:</i> | | 4. <i>Dr. W—n's Remarks.</i> |

P. 149. **A** Year or two after the preceeding Volumes were published, the little Sketch of Astronomy therein given, (or rather my Doubts concerning it) was warmly attacked, in the *London-Magazine*. The Substance of those Objections and of my Answer, I have here subjoined.

SIR,

I am obliged to you for your Queries and Remarks; and so I shall be to any who will point out any Thing wherein they think I have been mistaken. It would not be strange, if there should be many Mistakes in the "Compendium of Natural Philosophy." As Philosophy is what for many Years I have only looked into at leisure Hours. Accordingly in the Preface of that Treatise I said, "I am thoroughly sensible, there are many, who have more Ability, as well as Leisure, for such a Work than me. But as none of them undertakes it, I have myself made some little Attempt in the following Volumes."

Q. 1.

Q. 1. "You say, The Sun is *supposed* to be abundantly larger than the Earth. Is it not *demonstrable*, that he is so?"

I do not know whether it is, or no.

Q. 2. "Why do you say, the Moon is *supposed* to be forty-five Times smaller than the Earth, when the Moon's Bulk is nicely known?"

It is not *known* by me, nor, I doubt, by any Man else.

Q. 3. "You say, Jupiter is supposed to be twenty-five Times larger than the Earth: And in the next Page, that his Diameter is supposed to be 130655 Miles. If so, is he not 4096 Times larger than the Earth?"

Undoubtedly. But I do not undertake to defend either one Supposition or the other.

Remark 1. "You say, P. 148. Even with Respect to the Distance of the Sun, it is wisest to confess our Ignorance, and to acknowledge we have nothing to rest upon here, but mere uncertain Conjecture."

I did not say this, of the Distance of the Sun in particular. My Words, P. 146. are, "With Regard to their *Distance* from the Earth (the Distance of all the Bodies in the solar System) there is such an immense Difference in the Calculations of Astronomers, even with Respect to the Distance of the Sun—that it is wisest to confess our Ignorance," namely, with Regard to *their* Distance.

To prove that we are not ignorant hereof, you say "The Knowledge of the Sun's Distance depends on finding its Parallax, or the Angle that the Semi-diameter of the Earth appears under at the Sun, which Angle is so very minute, that an Error of but a single Second, will give the Distance very considerably greater or less than the true Distance." It will: and therefore I doubt, whether the Distance of any heavenly Body can ever be known by this Means.

"But Mr. Keil says, we are assured by various Methods made use of to observe the Sun's Parallax, that his Distance from us is more than twenty-eight Millions

Millions of Miles." He may be assured : But I am not. "He says farther, two eminent Astronomers have since determined the Sun's Distance to be about seventy-six Millions of Miles : Now if the least Distance possible is *absolutely determined*, how can it be wisest to confess our Ignorance ?" If it be—But I doubt, it cannot be determined at all : At least, not by the Sun's Parallax : "Seeing this is so very minute that an Error of a single Second will give the Distance very considerably greater or less than the true."

R. 2. "In P. 143, you tell us.—The whole Paragraph runs thus, "It is now almost universally supposed, that the Moon is just like the Earth, having Mountains and Valleys, Seas with Islands, Peninsulas and Promontories, with a changeable Atmosphere, wherein Vapours and Exhalations rise and fall. And hence it is generally inferred, that she is inhabited like the Earth, and, by Parity of Reason, that all the other Planets, as well as the Earth and Moon, have their respective Inhabitant's." [I take this to be the very Strength of the Cause. It was this Consideration chiefly, which induced me to think for many Years, that all the Planets were inhabited.] "But after all comes the celebrated Mr. Huygens, and brings strong Reasons why the Moon is not, and cannot be inhabited at all, nor any secondary Planet whatever. Then" (if the first Supposition sinks, on which all the rest are built) "I doubt we shall never prove that the Primary are. And so the whole Hypothesis, of innumerable Suns and Worlds moving round them, vanishes into Air."

In order to prove, that there are innumerable Suns, you say, 1. "It is found by Observations on the Parallax of the Earth's Orbit, that a fixed Star is ten thousand Times farther from the Sun than we are."

I can build nothing on these Observations, till Parallaxes can be taken with greater Certainty than they are at present. Therefore I shall want Proof, that any one fixed Star is one thousand Times farther from the Sun than we are."

2. "They

2. "They are fiery Bodies." I suppose they are, But this cannot be proved from their Distance, till that Distance itself is proved.

3. "It is demonstrable, that Sirius is as big as the Sun."

Demonstrate it who can.

4. "Seeing the fixed Stars are not much less than the Sun they are to be esteemed so many Suns."

Not much less! How is this proved? To argue from the Distance, is to prove *ignotum per æque ignotum*.

"You see, sir, the Hypothesis of innumerable Suns, is so far from vanishing into Air, that it is *almost altogether* founded on Demonstration."

Indeed I do not see one Title of Demonstration yet, from the Beginning to the End.

In order to prove that the Planets are inhabited, you say, 1. "The Earth is spherical, opaque, enlightened by the Sun, casting a Shadow opposite thereto, and revolving round it, in a Time exactly proportioned to its Distance. The other Planets resemble the Earth in all these Particulars. Therefore they likewise are inhabited." I cannot allow the Consequence.

2. "The Earth has a regular Succession of Day and Night, Summer and Winter. So probably have all the Planets. Therefore they are inhabited."

I am not sure of the Antecedent. But however that be, I deny the Consequence.

3. "Jupiter and Saturn are much bigger than the Earth." Does this prove that they are inhabited?

4. "The Earth has a Moon, Jupiter has four, Saturn five, each of them larger than ours. They eclipse their respective Planets, and are eclipsed by them."

All this does not prove that they are inhabited.

5. "Saturn's Ring reflects the Light of the Sun upon him."

I am not sure of that. And till the Fact is ascertained, no certain Inference can be drawn from it.

6. "But

6. "But is it probable, God should have created Planets like our own, and furnished them with such amazing Apparatus, and yet have placed no Inhabitants therein?"

Of their Apparatus I know nothing: However if all you assert be the *Probability* of their being inhabited, I contend not.

7. "They who affirm, that God created those great Bodies, the fixt Stars, only to give us a small, dim Light, must have a very mean Opinion of the Divine Wisdom."

I do not affirm this, neither can I tell, for what other Ends he created them: He that created them knows. But I have so high an Opinion of the Divine Wisdom, that, I believe, no Child of Man can fathom it. It is our Wisdom to be very wary how we pronounce, concerning Things which we have not seen.

R. 10. "Suppose some intelligent Beings in one of the Planets, who were

Slaves to no Sect, who sought no private Road, But look'd thro' Nature up to Nature's God, viewed the Earth from thence, they would argue, it must be inhabited, as we argue that the other Planets are. But the Superstitious would oppose this Doctrine, and call it mere uncertain Conjecture."

I see no Argument in this: But perhaps I do not understand it. Are you applauding the supposed Inhabitants of Venus, for not being *Slaves* to the *Christian Sect*? Otherwise what has *Superstition* to do in the Case? Why is this dragged in by Head and Shoulders. If there be Superstition here, it is on *your* Side, who believe, because you *will* believe: Who assent to what you have no Evidence for, and maintain what you cannot prove. At present, you are the *Volunteer* in Faith: You swallow what choaks my Belief.

R. 2. "You quote, Dr. Rogers"—But I do not undertake to defend his Hypothesis, or any other: "Our best Observators could never find the Parallax of

of the Sun to be above eleven Seconds." But I cannot depend on their Observations: Especially when I find one of the chief of them, in computing the Distance of the Sun, to stride from twenty eight Millions of Miles, to seventy-six! Near fifty Millions of Miles at once! After this, let any impartial Man judge, what Stress is to be laid on Parallaxes!

"But Dr. Rogers supposes the Parallax of the Sun to be five Minutes, which others cannot find to be above eleven seconds. Why, Doctor, if this be true," (namely, that the Parallax which was lately but eleven Seconds, is now increased to five Minutes) "the Earth has *approximated* thirty Times nearer" (a little harmless Tautology) "to the Sun." That is, if both the Computation of Mr. Keil, and that of Dr. Rogers be true? But who ever supposed this? If the one be true, the other is undoubtedly false.

"To conclude. Since there is no arguing against Facts, and since the Sun's Parallax is found not to exceed eleven Seconds, ought you not to give up that Hypothesis as absurd and ridiculous?"

Yes, as soon as any of those Facts appear: Till then I neither espouse, nor give it up. But I still look upon it as extremely ingenious, and full as probable as any other.

Before I conclude, permit me, Sir, to give you one Piece of Advice. Be not so *positive*: Especially with Regard to Things which are neither easy nor necessary to be determined. I ground this Advice on my own Experience. When I was young, I was *sure* of every Thing. In a few Years, having been mistaken a thousand Times, I was not half so sure of most Things as before. At present I am hardly sure of any Thing, but what God has revealed to Man.

Upon the whole, an ingenious Man may easily flourish on this Head. How much more glorious it is for the great God to have created innumerable Worlds, than this little Globe only! But after all, I would ask one plain Question. Suppose there are more Worlds

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than

than there are Sands on the Sea Shore: Is not the Universe finite Still? It must be, unless it be God. And if it be finite, it can still bear no Proportion to him that is infinite: No more than this Ball of Earth does. How large so ever it be, still, compared to Him it is as nothing, as the small Dust of the Ballance. Do you ask then, what is this Spot to the great God? Why, as much as Millions of Systems. Great and little have Place, with Regard to us: But before him they vanish away. Inlarge the Bounds of Creation as much as you please, still it is but a Drop to the Creator.

And still the Power of his Almighty Hand
Can form another World from every Sand!

Yet were this done, there would be no more Proportion between the World, and its Creator, than there is now!

It will easily be observed, that I do not deny, but only doubt of the present System of Astronomy. But the ingenious Mr. Kennedy goes much farther in his *Astronomical Chronology*. I beg Leave to present the impartial Searchers after Truth, with a short Extract from it.

"Altho' many Persons of great Abilities have thought sacred Chronology worthy their most diligent Researches, yet they have all failed in the main Point. They have taken it for granted, that the scriptural Computations are quite Unastronomical. The Title of *The World's Chronology* has been fixt to very different Collection of Years, without looking for any scriptural, astronomical Æra, to support the Title. This is the first Attempt of that Kind which has been made.

"I have largely proved the fundamental Proposition of the following Scheme, namely, That *Moses* fixes the Position of the Sun and Moon with Regard to each other at the Creation. And this revealed Position of the Sun and Moon, with Respect to each other

other at the Creation, I call the scriptural, astronomical *Æra*:

By Means of this *Æra* we may keep even Pace with the two great Luminaries, from the first Year of the World till now. And till now my Conclusions are confirmed, by the joint Attestations of the Sun and Moon, the two *faithful Witnesses in Heaven*.

By these it is fully proved, that Time commenced at our autumnal Equinox, at the fourth Day of the Creation, at the Full-Moon, or the fifteenth Day of the first Month of the first lunar Year.

From the autumnal Equinox at the Creation to the same in 1761, have elapsed 5768 Years. Indeed *Cassellus* supposes Time to commence two Years, *Archbishop Usher* four Years later. But could the Error of a single Year be discovered in the Series I have collected, all would fall to the Ground.

Touching the common Astronomy I observe, 1. Astronomers still divide the Ecliptic into 360 Degrees. But how unnaturally? Three Hundred sixty Degrees, and near one-fourth, are undeniably more correspondent to the Sun's annual Motion. And upon this Division we can make a truer Calculation, than can be made upon any other.

2. The Inequality of solar tropical Years, and the Inequality of the Equations of natural Days, are established Doctrines. But whoever computes the Times of Equinoxes and Solstices, and submits his Calculations to the Test of the latest and best Observations will find no Room for any Equations at all.

3. Astronomers unanimously maintain, that at the End of 19 lunisolar Years, the mean New Moons, and the mean Full Moons happen, about an Hour and an half sooner than they did at the Beginning of the Cycle. On the Contrary, I undertake to evince that the very Reverse of this is true. I allow, that at the End of nineteen lunisolar Years, the Moon departs from the Sun: But it departs from it, not by a Retrocession.

Retrocession Westward, but by a Progression Eastward. That is, the mean New Moons, and the mean Full Moons fall out, not an Hour and an Half sooner, but almost two Hours later. Therefore the Doctrine of Lunar Anticipations has no Foundation in Nature.

4. Altho' the Quantity of a *solartropical Year* is a Conclusion in Astronomy, yet such an unhappy Fatality has attended this Research, for almost two Thousand Years past, that whoever examines the vast Variety of Opinions, must see, nothing has yet been determined with Certainty. So that instead of a precise and established Definition, he finds little more than this general Account, that the Quantity of the natural Year has been long and much sought after, but with small Success: So that it seems at this Day to remain among the yet undiscovered Secrets of Nature.

Indeed to know this with all Exactness, one would think no more is needful, than to examine the Tables of Observation. Let us then examine that made by *Tycho Brahe*, in Queen Elizabeth's Time, and that by *Dr. Bradley*, an Hundred and seventy Years after. But in *Tycho's* Table of twelve Terminations, seven of them differ a Minute from the other five. And this Difference perplexes the Conclusion, and leaves it in a State of Uncertainty. Proceed we then to *Dr. Bradley's* Tables. But these leave a Latitude of twenty-one Minutes. Thus we see, how imperfect the Knowledge, even of the solar tropical Year still is, and that no true Judgment can be formed concerning it, either from Observation, or tabular Calculation.

5. It requires no small Skill, even to determine the Distances of the Sun's four Stations, at the vernal and autumnal Equinox, and the Summer and Winter Solstice. Nay it is a Question, whether this Determination likewise must not still be reckoned among the Secrets of Nature.

And if we would correct the Tables of these by *Dr. Halley's* Rule, yet this very Correction leaves us

four

four Different Measures, according to the Majority of *Tycho Brahe's* Corrections, according to Sir *Isaac Newton's*, Dr. *Halley's*, and Dr. *Bradley's* Corrections. So that still we come to no Certainty, even as to the solar Stations. We are at a Stand, like a Traveller, who arriving at a Place where four Ways meet, is at a full Stop, for Want of a clear Direction, which of them to take.

6. The greatest Astronomers are not agreed, even as to the Length of a natural Day.

Mr. *Ferguson* observes,

The fixt Stars appear to go round the Earth in 23 Hours, 56 Minutes, and four Seconds, and the Sun in 24 Hours. Therefore in the 365 Days measured by the Returns of the Sun to the Meridian, there are 366 Days as measured by the Stars returning to it. The former are called *Solar* Days, the latter *Sidereal*. But whoever will compare this with the Determinations of Dr. *Kell*, will find them flatly contradictory to each other. And the farther he examines the most celebrated Writings, the more deeply he will be convinced, that neither the precise Length of a sidereal Day, nor the Complement of the Solar, has yet been determined with Certainty."

Whoever desires to see these Propositions proved at large, may have Recourse to the Book itself. But if these Things are so, what becomes of the whole Fabric of even *Newtonian* Astronomy? How can I depend on the Calculations of those concerning the Motions of the Heavens, who know so little about the Earth? What Instruction can they give me concerning other Systems, who are so unskilled with Regard to our own? Why does not some eminent Astronomer undertake this daring Man, who so violently attacks the very Foundations of their Building? For if his Remarks are just, sensible Men will be inclined to think, that after all the Parade of Mathematical Demonstration, there is little more Certainty in *Astronomy* itself, than even in judicial Astrology!

And how just are the great Mr. Boyle's Remarks, upon the whole of *Natural Philosophy*? "The most, says he, even of modern Virtuoso, fancy more Certainly in their Physical Theories than a critical Examiner will find. I will touch only on two Subjects, which we commonly think are, and which surely ought to be, most thoroughly understood: I mean, the Nature of *B. dy in general*, and the Nature of *Sensation*. As to the first, since we can turn ourselves no Way, but we are invironed by corporeal Substances, one would think, an Object that so many Ways affects our Senses, should be perfectly known to us. And yet the Notion of Body in general, or what it is that discriminates Bodies from other Substances, is not by any Means agreed, even among the modern Philosophers. And indeed no Account of it which has yet been given, will extricate us out of the Difficulties of that no less perplexed than famous Dispute, "Of the Composition of Bodies." But the Difficulties attending this, will, till they are removed, spread a thick Night over the Notion of Body in general. For either a corporeal Substance is divisible into extended Parts, and each of these divisible into other Parts smaller and smaller *in infinitum*, or this Division must stop somewhere. But there are Inconveniences, not to say Absurdities, urged against either of these Suppositions. The Objections on both Sides are so strong, that the most sensible and candid Men, after having tired themselves and their Readers with striving to solve them, have at Length owned them to be insoluble.

"But tho' we do not understand the Nature of Body in general, must we not perfectly understand what passes within ourselves, in Reference to the particular Bodies we daily see, and hear and smell, and taste and touch? These we know by our Senses: But how little do we know, of the Manner wherein our Senses inform us of any Thing? Sensation, we allow, is not performed by the Organ, but by the Mind perceiving the Motion produced in the Organ. Ask then

then a Philosopher, how the Soul comes to be wrought on, and that in such various Manners, by those external Bodies, which are the Objects of our Senses? He will tell you, that by the Impressions on the Organs, they variously move the nervous Fibres, wherewith those Parts are endow'd, by which the Motion is propagated to the Brain: Where these Motions being perceived by the Soul, become Sensations, thro' the intimate Union of the Soul with the Body. But give me Leave to take Notice, that this Union of an incorporeal with a corporeal Substance, is a Thing so difficult to comprehend, that the profoundest Secrets of Theology, not to say the Incarnation itself, are not more abstruse than this. For how can we conceive, that a Substance purely immaterial, should be united without any Medium (and in this case there can be none) with a Body that cannot possibly lay hold on it, and which it can pervade, and fly away from at Pleasure? And 'tis almost as difficult to conceive, how any Part of the Body, without excepting the animal Spirit of the Brain (for these are as truly corporeal as the other Parts) can make Impressions on a Substance perfectly incorporeal, and which is not affected by the Motions of any Parts, but the Nerves. Nor is it a small Difficulty to conceive, how a finite Spirit can either move, or (which is much the same Thing) regulate and determine the Motion of the Body.

And suppose the Soul in the Brain does perceive the different Motions communicated to the Senses, yet this, tho' it may give some Account of Sensation in general, does not give us any satisfactory Reasons of particular Sensations. For if I demand, for Instance, why when I look on a Bell that is ringing such a Motion, in the Brain produces in the Mind the Perception of Seeing and not Hearing: And another Motion, coming from the same Bell at the same Time, produces in the Perception of Hearing, not Seeing: What can be answered, but that such is the good Pleasure of the Author of Nature. And if we ask about the differing

differing Objects of any one Sense, as, Why the Light reflected from Snow, produces a Sensation of Whiteness rather than Redness? Why Castor produces a Stink, and not a Perfume? Why sweet Things generally please, and bitter disgust us? Nay, why a little of some Objects (suppose Fire) will give Pleasure, a little more of them give Pain: To these and a Thousand other Questions of the same Kind, it can only be answered, Such is the Nature of Man. So plain is it, that we are yet to seek, both for the Definition of a corporeal Substance, and for a satisfactory Account of the Manner of our own Sensations. Yet without the true Notion of a Body, we cannot understand the Object of Physics in general: And without knowing the Nature of Sensation, we are ignorant of that, from which we derive almost all that we know of any Body in particular.

And as our Philosophical Knowledge is not very deep, not reaching with any Certainty to the Bottom of the most obvious Things, nor penetrating to their inmost Nature: So it is not very wide, not being able to give us with any Clearness or Particularity, an Account either of the celestial Parts of the World, or of the deeply subterraneous Parts: Of which the superficial Part is but a small, not to say, contemptible Portion. As to the very Globe we inhabit, (not to mention how many Plants and Minerals we are wholly ignorant of, and how many others we are but slenderly acquainted with) the Objects about which our Enquiries and Experiments are conversant, all belong to the superficial Parts of the Globe, of which the Earth known to us is but the Crust. But what the internal Part of it is we no more know, than what is the Substance of the remotest Stars. Even among the Moderns some think the internal Part of it, is pure, elementary Earth. Others imagine it to be Fire, the Receptacle of natural or hellish Flames. Others will have it to be a solid Magnet; while others believe, it was once a fixt Star: And that tho' it is now degenerated into a Planet, yet its
internal

internal Parts are of the same Nature it was before : The Change proceeding only from thick Spots that cover it, (like those frequently observed upon the Sun) by the Condensation whereof the firm Earth which we inhabit was formed. And it is as difficult to demonstrate the Falshood, as the Truth, of each of these jarring Opinions. For whereas it is at least three Thousand five Hundred Miles to the Center of the Earth, it does not appear, that Men have been able to penetrate toward it, either by Land or by Sea, above one, or two Miles at the most, and that not in above three or four Places. So that as yet we have not grated any Thing deep upon the Husk, without at all reaching the Kernel of the Globe. And what is this Globe, of which itself we know so little, to those vast Globes, of which we know much less ? For tho' the former Astronomers give us their Distances and Magnitudes as exactly as if they had measured them, yet the later Mathematicians give us Reason to doubt of what those have delivered. For since we can observe no Parallax in the fixt Stars, (nor perhaps in the highest Planets) we must still be to seek for a Method to measure the Distance of those Bodies. And not only the Copernicans make it many hundred thousand Miles greater than the Ptolemeans, but *Ricciolus* makes it vastly greater, than the Copernicans themselves. Nor can we wonder at these huge Discrepance, (tho' some amount to many Millions of Miles) when we consider that Astronomers do not measure the Distance of the fixt Stars by their Instruments, but each accommodates the Distance of them, to his peculiar Hypothesis. From this Uncertainty of the Distance of the fixt Stars, 'tis easily infer'd, that we are not sure of their Bulk : No, not even in Reference to one another; since 'tis doubtful, whether the different Sizes they appear to be of, proceed from an Inequality of Bulk, or only from an Inequality of Distance. But beside these, there are divers Things relating to the Stars, so remote from our Knowledge, that they are not even enquired

enquired into: Such as these, Why the Number of the Stars is neither greater nor less than it is? Why so many of them are so placed, as not to be visible to the naked Eye? Why of the visible ones, so many are in one Part of the Sky, and so few in others? Why they are not placed in some Order, but scattered over the Sky, as if it were by Chance? Many Questions might be added, as concerning the Stars, so concerning the interstellar Parts: As whether they are empty, save where they are pervaded by Light, or filled with ethereal Matter? So that our Knowledge is much short of what is generally thought. For the Earth being but a Point, compared to the Orb of the Sun: Which Orb itself is but a Point in Respect of the Firmament: Of how little Extent must our Knowledge be, which leaves us totally Ignorant, of so many Things touching the vast Bodies, which are above us, and penetrates so little a Way into the Earth beneath us, that it seems confined to but a small Share of the superficial Part of a Physical Point."

We are assured by the Observations of Astronomers, that the Motion of the Earth in its Orbit is not equal; but in some Places it moves quicker, in other Places it slackens its Pace. In our Summer the Sun is observed to go in a slow Motion. In our Winter he moves somewhat faster: On which Account, he is observed to spend near eight Days more in the Northern Signs of the Ecliptic, than in the Southern Signs: So that from the Time of the Sun's being in the Vernal Equinox, till his Coming into the Autumnal, there are 186 $\frac{1}{2}$ Days; in which Time by his apparent Motion, he is seen to describe one Half of the Ecliptic: But from the Autumnal to the Vernal Equinox, there are only 178 $\frac{1}{2}$, in which Space of Time he finishes his apparent Course thro' the other Half of the Ecliptic, and visits all the Southern Constellations. We are also assured by the Observation of Astronomers, that the apparent Diameter of the Sun

Sun, in Winter, when his Motion is quickest, is greater than the apparent Diameter in Summer, when his Motion is slowest; and the Difference is so great, that when the Sun appears biggest. He is seen under an Angle of 32 Minutes 47 Seconds: But when he appears least, subtends an Angle, only of 31 Minutes 40 Seconds; and therefore the Sun must be farther from us in Summer than in Winter; and consequently, he is not in the Centre of the Earth's Orbit.

Perhaps it will be acceptable to calm, dispassionate Men, if I add yet another Extract from a very sensible Writer, containing a few short Observations, on the whole present System of Philosophy.

1. "The first Axiom in the present Philosophy is, That all Matter is indifferent to Motion or Rest. But do we not here stumble at the Threshold? Laying as a fundamental Truth, what is manifestly false? For Motion and Rest are such opposites, that it implies a Contradiction, to suppose an equal Disposition to either, inherent in the same Body. The one is a *Positive*, which necessarily implies Power, the other a mere *Negative*, which implies no Power in any Direction.

2. Matter containing in itself no Power of any Kind, can give no *Resistance* to any Impression upon it: Neither can it of itself *continue* to exert the Effects of that Impression. Therefore the second Axiom, or rather the Phenomena, from which it is deduced, must arise, not from Matter in itself, but from the Relation which all Matter bears to the universal System of Nature.

3. The third Axiom, concerning *Re-action* is as exceptionable; as the two former. For it may easily be shewn, that the Re-action of Matter depends entirely on Gravity. If Gravity were subtracted there is no Proof or reason to suppose, that Bodies would exert either Resistance or Re-action. All these Axioms therefore, instead of being absolute Laws, are mere Phenomina

Phænomena depending on other Causes, which Causes it is incumbent upon the Philosopher to look for.

4. The *Projectile Power* never can ballance that of *Gravitation*, so as to maintain the Motion of the Planets. It can never recover its Force when it is resisted, whereas Gravity can. Therefore the constant bending of its Direction, which must be equal to a constant proportionable Resistance, must uniformly and perpetually weaken its Power and strengthen that of Gravitation: So that the Direction of Motion must necessarily sink more and more, and at last fall wholly into the Direction of Gravitation. It follows that no Power acting upon an Orb which gravitates toward its Center of Motion, can possibly maintain its projectile Motion, in the Direction of a Circle.

5. Even on Supposition, that Projection and Gravitation equally retained their Propensity to Motion tho' resisted, yet these Powers could not move the Planets in Ellipses, because in the same Proportion as the one prevailed over the other, in the same Proportion it must alter the Tendency of Motion toward its own Direction. And none can explain, how when a Quantity of Motion and also of Inclination is gained by Gravitation over Projection, the Orb will, while these remain unchanged, leave at any Point the Direction of the moving Power that prevails, and recede into the Direction of the weaker Power, or *contra*.

6. Again, From the Proportions of the Forces required between Gravitation and Projection, in order to move the Orbs in Circles, it is evident that these two Powers cannot be the Cause of their Motions. For by comparing the Forces of these it appears, that the Force of Gravitation is not such in Proportion to that of Projection, as to bend the Direction of the projected Body sensibly from the right Line.

7. The

7. The Motion of the *Moon* along with the *Earth*, cannot be owing to her gravitating toward it, nor to a Projection imprest upon her, in common with the *Earth*; because she has a Projection of her own round the *Earth*. And she cannot be so projected as to move in two different Orbits at one and the same Time, by the *vis inertiae* continuing one projectile Motion round the *Sun*, and another round the *Earth*. Therefore the Motion of this, and by a Parity of Reason, that of all the Secondary Planets, must be guided every Moment either by Mechanism or by a spiritual Power.

Indeed Sir *Isaac* thought these Powers might arise from a subtle, ethereal Medium, diffused through the whole Universe: But this is only retiring a Step farther in the dark. For it comes to one, whether the Cause of Attraction be assigned to grosser Bodies themselves, or to the Impulse of a Medium that penetrates them. If the Powers of that supposed Medium are unmechanical, they must be spiritual. And seeing the Medium is only supposed, it is more natural to assign these unmechanical Powers, to Bodies which we know disposed to these Motions, than to supposed Bodies, which we know nothing of.

Farther. If Sir *Isaac* supposes such a Medium for maintaining Attraction, Gravitation and Elasticity; how came he not to suppose, that the same is concerned, in supporting his Axioms or Laws of Motion? For the Knot does not lie in Gravitation or Attraction, or any particular Kind of Motion, but in finding Powers to produce and maintain Motion in general. If these are mechanical, it is easy to suppose, though we should never be able to explain in what Manner, that the Contriver has adjusted the Mechanism to produce all the Motion observable in the Creatures. But if they are unmechanical Laws, Properties or whatever we may call them, there is no Occasion for supposing any Cause of Gravitation, or for taking it amiss to have it called occult Quality, unknown

known Virtue, Charm, Law, or any Word we have no Meaning to.

8. This unmechanical Philosophy has a bad Influence in obstructing our Advancement in the Knowledge of Nature. For how can Enquiries into the Powers of Nature, be carried on to any Degree of Perfection, under the Direction of a System which muffles our Eyes with unmechanical Laws of Matter, supposes the Basis of Mechanism, instead of examining whether these themselves are not the Production of Mechanism? Such are the Indifference of Matter to continue itself either in Rest or Motion: Reaction equal to Action: The Resistance of Matter to a Change of State: Gravitation, Attraction, Repulsion, Elasticity: Pressure of Fluids in all Directions: A Fluid with no Cohesion of Parts, moving in diverging Lines; whose Parts are possess'd of different Degrees of Attractability by other Bodies, contrary to that Law which makes Gravitation simply as the Quantities of Matter: A Fluid possess'd of alternate Fits of Attraction and Repulsion! How weak is it, to make these the Basis of Mechanism, rather than the Result of it?

9. Let us now examine these Matters more closely. In the present Philosophy, *Space* is always considered in the first Place; because without admitting Space void of Matter, the whole System falls to the Ground.

This same infinite Space is the most wonderful Thing within the whole Range of Being. It is neither God nor his Creature, and yet is inseparable from the Being either of God or of any Thing he can create. It is infinite both in its Extension and in its Duration. It is immovable and indivisible. If a compleat Definition of it were put into a Lady's Pocket-Book, she would guess it to be an Enigma for nothing: And would be astonish'd to hear, that it is the Quintessence of a most metaphysical and most subtle Argument, maintained by a most celebrated Divine and Philosopher.

The

The only positive Idea applied to Space is *Extension*. But we can apply no Idea to any Subject, which the Subject itself does not impress. Matter forces upon our Senses the Idea of its Extension. But how can we invest with this, a Subject which never excited any Idea in us, and consequently has no Existence to us? Space is only one of the Ideas excited by Matter, and by the Mind abstracted from its Subject, just as we can image a Colour to ourselves, without connecting any particular Subject with it. A little more of the same Metaphysics, which can prove that *Nothing* is extended, will prove that Space is Purple. But why should I say Purple? Space is of all Colours, if Light is reflected by a Vacuum. It is an ingenious Contrivance, to render *Nothing* a Subject of Conception, by dressing it in a Suit of Cloaths borrowed from *Something*.

To illustrate the Doctrine of Space, a common Experiment shews, that by an Image formed in the Air, at a certain Distance between a concave Glass and any Person looking into it, Extension becomes an Object of Sense, where there is neither Solidity nor any sensible Resistance. But this does not prove, that an Image is formed in empty Space, or where there is no Matter. It rather proves, that these Spaces which they call empty are full of Matter. For as the Senses can be effected only by Matter, they infallibly determine where Matter is. So that we are as sure there is Matter where we see any Thing, though we cannot feel it, as that it is there, where we feel, though we cannot see it.

10. Let us now more attentively consider the first supposed Law of Motion, *Matter is indifferent to, continue in Motion or in Rest.*

Rest and Motion are the two greatest Opposites in Nature, as opposite as Matter and Nothing. The Mind therefore cannot be struck with a more palpable Contradiction, by affirming that a Body is equally disposed, to Hardness and Softness at the same Time,

Time, than by saying it is equally disposed to Rest and Motion.

Motion is a positive Thing, which implies Action, Power, or Force, wherever it acts. Rest is a mere Negative, a State wherein Body is divested of all these. It exerts no Power; it acts or presses, neither backward nor forward, neither up nor down. Now the same Body cannot be indifferent to the exerting of Power and to the exerting of none at the same Time.

Again. It is impossible that Rest and Motion can be equally indifferent to Matter. When Matter was created, should we suppose the Creator to say, "Let it be," *without* determining in which of these States it should commence Being, yet it is impossible it could begin to be, both moving and resting. It could assume only one of these Conditions, and must have remained therein for ever, unless some farther Divine Energy had given it a new Determination. Now in which ever of these Matter began to exist, that must be called its *Natural State*. And every Alteration of that State, must be the Effect of some Power superinduced upon it, which must cease when the Cause ceases.

Again. Matter may exist in Rest: but no *living* Matter. All Life in Nature, whether mineral, vegetable, or animal, depends upon Motion and Activity. Therefore Motion seems to be not the natural State of Matter, but superadded thereto and constantly supported, in order to constitute Life, Variety and Mutability. Now all know, material Motion proceeds upon, and is regulated by mechanical Laws. And does not Motion uniformly conducted by the Laws of Mechanism, imply a constant mechanical Cause? This mechanical System is traceable in most Cases, even in the most subtle and elaborate Works of Nature, such as Plants and Animals. And may not the same Heavens which influence every Thing on Earth, rule the Motions of the Earth itself; and

impress

impress all Matter which these general Tendencies, which are the Basis of all human Mechanics?

11. Proceed we to what is called the *second Law of Motion*. We can have no Idea of Power, but that it is Matter in Motion, or endeavouring to act; We cannot connect the Idea of Power with Matter at rest, unless that Rest be the Effect of Power-fixing it in its Place, which we may term *mechanical Power*. This Rest, being an Effect of Power, will exert a Resistance to Motion, when it is prest upon. But otherwise, Matter can have no such Power in itself, can exert none; because Power consists in Motion, or a Nisus to it. Therefore Matter resting *unmechanically* can have no Nisus of any Kind. An *unmechanical Nisus* in Matter to Rest, is in other Words, an *active Power* exerted by it to do nothing.

The States then of Motion or Rest being the Result of absolute Passiveness in Matter, and the Effect of no positive Nisus, an *unmechanical Matter* can exert no Resistance to change the State: And of Consequence an Atom would have as much Power to move a Planet, as a Planet to move an Atom.

An Action or Tendency to Action is plainly implied in a Nisus to any State. And as a Nisus to Passiveness is a Contradiction in Terms, it follows, that the Properties of Power or Motion, cannot be considered in Matter taken abstractedly, but as composed into a System. Therefore tho' it must be allowed, that the Changes of State in Matter are proportioned to the Powers that produce them, yet it is impossible to conceive, that the Power shall continue in the Body acted upon, after the exterior Power ceases to act upon it.

12. The *third supposed Law of Motion* is this. When Matter is put into Motion, it communicates as much Resistance toward stopping the Motion of the Body that moves it, as it receives Motion from it.

Philosophers never had it in their Power to make the Experiments on which this Law is grounded,

upon any Bodies but such as were under the Influence of Gravitation. And if this Axiom can be proved to depend upon Gravitation, it must cease to be an Axiom, as being only an Accident depending upon another acknowledged Cause.

Resistance or Re-action must be produced wherever Matter in Motion incounters Matter moving or tending to move in an opposite or a different Direction. Now all Bodies tend or gravitate toward the Earth. Therefore this Tendency must re-act or resist according to its Quantity, every Power applied to move a gravitating Body in any other Direction.

We have no Way to estimate the Quantity of Matter contained in any Bodies, but the Quantity of their Gravitation. Hence we must necessarily infer, that the Law of Re-action, is not according to the Quantity of Matter in particular detached Parcels thereof, but according to the Degree of their Gravitation. For where the Gravity of a Body but the Half of what it is now, that Body would re-act but half as much as it does; and of Course, were all its Gravitation to cease, it would not re-act at all.

Again. It is supposed, Gravitation is 23 Times greater on the Surface of the Sun, than on the Surface of the Earth. Hence a Body which weighs one Pound here, would there weigh three and twenty. Consequently, without any Addition of Matter, it would re-act twenty-three Times more than it does here. Therefore this Re-action, supposed an absolute Law of Matter, is only a Circumstance depending on the relative Law of Gravitation.

13. Come we now to the Doctrine of *Centripetal* and *Centrifugal* Forces. In another Age it will be Matter of universal Wonder, that one of the most profound Mathematicians in the World should assume two Powers for circulating the Planets, and even calculate the Quantities of Matter therein, from the Proportions wherein they must act in producing and maintaining the Circuits of the moving Stars; While it is demonstrable to common Sense, from the admitted

ted Nature of these two Powers, that it is absolutely impossible they can support one single Rotation of an Orb.

Gravitation is allowed by all, to be a constant Power in Bodies, which cannot be altered but by Change of Distance. It cannot be suspended; for though its Effect may be resisted, yet its Tendency thereto is invariable. It is therefore a proper, undefeasible Power, uninterruptedly acting in and upon Bodies.

The Laws assigned to *Projection* are just the Reverse. When any Proportion of the Quantity of Projectile Motion is destroyed, either by direct Opposition, or by Change of its Direction, it exerts no Nisus to recover its first Quantity of Motion. Consequently as long as any Power such as that of Gravitation, is bending the Direction of Projection, it is a continued Resistance to the Power of Projection, which is continually diminished thereby. And as it has no Tendency to recover this, the smallest continued Resistance will at last quite exhaust its Power, tho' originally ever so great. Thus every Projectile on the Earth, however great the projecting Force may be at setting out, is continually retarded till it rests in the Direction of a parabolic Curve.

Sir Isaac seems not to have reflected on this Circumstance of Gravitation and Projection, that the one retains its whole Tendency to Motion, whether it be retarded or stopt, while the other always loses as much Power, as it meets with Opposition. Neither in balancing these Powers, does he seem to have reflected on that obvious Truth, That every Alteration in the Direction of a moving Projectile, destroys so much of its Motion, which cannot be repaired, but by a continued Action of the first moving Cause.

Philosophers illustrate the joint Effect of centripetal and centrifugal Force, in making Bodies move in a Circle, by the Experiment of casting round a Weight, suspended by a String in ones Hand. But this Illustration contains a palpable Deception. For the Power of the String restraining the Body from flying

ing off in a strait Line, bears no Analogy to a Power actually drawing a moving Body towards its Center of Motion. The String resists its flying off, but has not the least Tendency to draw it nearer. And whatever is the Cause of the Revolution of the Planets, it must be some Cause which simply resists their flying off into eccentric Motions. It cannot in the Nature of Things be one, which is uniformly drawing them into their Center of Motion.

But suppose both Gravitation and Projection had the same Property, of still retaining their original Tendency to their respective Motions, however they were retarded: Still it is impossible that these two Powers, acting by immutable Laws, can move an Orb any otherwise than in a Circle: Whereas all the Planets are allowed by Philosophers themselves to move in Ellipses.

These Powers moving an Orb in the Figure of an Ellipse, must no less than four Times, vary the Proportion of their several Impulses, during every compleat Revolution. The Power of Gravitation is uniformly gaining on that of Projection, from the higher Point of the Ellipses to the lower. Now (not to ask, how the projectile Force recovers itself, but supposing it had this Property) I ask, by what Law does Gravitation remit the Strength it has gained, in bringing the Orb from the higher Point to the lower, and at that Point allow Projection to recover the Force it had lost, in order to carry it back to the higher Point? In like Manner, seeing Projection has been gaining on Gravitation, all the Way to that Point, how comes it all at once to lose its superior Force there? And how comes Gravitation immediately to preponderate, in order to bring the Orb to the lower Point again?

It cannot be said, that the increased Velocity, which brings a Planet to the lower, contributes to carry it back to the higher Point. For that increased Velocity was not the Effect of Projection but of Gravitation. Therefore the Orb can never get out-ward

ward again, unless at that Point, Gravitation all at once, weakens its Pull of the Planet inward.

There is one Circumstance more, which Mathematicians ought to consider well: Namely, That no Figure (Circle or Ellipsis) can be described by Gravitation and Projection round the Center of Gravity, where that Center of Gravity shall not be found in the Center of the Figure. But this is Contrary to all Astronomical Observation upon the Motion of the Planets, which determines their Center of Gravity to be always in one of the Foci of their elliptical Orbits.

Yet farther. In order to move any Body in a Circle, the moving Powers must be equal, or nearly so. Now the Proportion of the moving Powers upon one Body to each other, can only be determined by the Velocity of the respective Motions. Indeed the Quantity of Motion in different Bodies must be determined, by the Quantity of Matter moving and Velocities taken together. But in one and the same Body it may be determined solely, by the Velocity of its Motions.

Equal Powers then can only be determined by the equal Quantities of Motion they produce. But as to the Powers of Gravitation and Projection, the Proportion between them as ascertained by the ablest Mathematicians, is so far from being equal, that the immense Disparity between them, can scarce be reduced to a Calculation. Therefore it is utterly impossible that these two Powers should produce the Revolution of the Earth.

If the Sun and Earth were as near each other as the Earth and the Moon are, and were left to the Power of their mutual Attraction, they would move toward each other with the same Velocity as it is supposed the Earth and Moon do, which I think is about sixteen Feet in a Minute: Except so far as the Proportion of Matter in the Earth to that in the Sun, differs from that of the Earth to the Moon. If then the Earth at that Distance from the Sun, would gra-

vitate

vitate toward him with the Velocity of sixteen Feet in a Minute, and if the Decrease of Gravitation, be inverfely as the Squares of the Distances, (that is, at double Distances, four Times lefs) then the Earth being immensely farther from the Sun than the Moon is from the Earth, the Velocity with which the Earth at her present Distance from the Sun would move toward him, if left to the Power of Attraction, must be immensely lefs than sixteen Feet in a Minute. But what is the Force which moves the Earth sixteen Feet or a Thousand, to the Force of that Projection, which is supposed to move it at the Rate of near a thousand Miles in a Minute?

In short, if the Power of Gravitation draws the Earth toward its Center of Gravity, with the Force of sixteen Feet, or 1600 in a Minute, while the Power of Projection impresses it with the Force of almost a thousand Miles in the same Time, it is impossible for Mathematics to demonstrate, that any Orb hurried off by such a Projection, can ever be recalled from its eccentric Motion, by such an inconceivably small and disproportionate Resistance: Especially as the Power of Gravitation, small as it is, must be growing smaller every Moment. Nor can the Mathematical Properties of an Ellipsis or any Figure, ever prove that Gravitation, which is continually wasting and spinning out into a cobweb Thread, will at any Point recover a Superiority to the projectile Force; and grow at least a Cable, massy and powerful enough to bring home the wandering Star again.

14. I would add some Thoughts on the Motion of the *Satellites*. It is no Wonder, that notwithstanding all the Arguments for the Motion of the Earth, yet the greatest Part of Astronomers have not pronounced it absolutely certain, but only probable in an high Degree. Among the Perplexities which attend this highly probable System, the Doctrine of *absolute Motion* is not the smallest. 'Tis certain all the Phenomena of relative Motion, are the very same as if the Earth were at Rest. And it is not easy to conceive

ceive, how this can possibly be, on the Supposition of the Earth's Motion.

The Phenomena of Bodies moving in the same Direction with the absolute Motion of the Earth may be comprehended. That Motion of Bodies cross the absolute Motion of the Earth is also intelligible. But it is no easy Matter to satisfy oneself, about the Phenomena of Bodies moving Westward, or in an opposite Direction, to that of absolute Motion. If we should suppose that a Ball fired Point-blank West, does not really move Westward, but is only resisted by the Explosion from moving so fast East as the Earth goes in her absolute Course: May it not be asked, What is it, that keeps the Ball suspended, while the Earth proceeds in her absolute Motion? For the Resistance given to the progressive Motion of the Ball, can be no Resistance to its following the Course of its Gravity: As we have no Example to explain, how Resistance applied horizontally will prevent a Body's falling to the Ground in the same Time as if it was not so resisted. If the Ball's absolute Motion is only the Force of its *vis inertia* derived from the Earth's Motion, and its apparent Motion in a contrary Direction is only from another *vis inertia*, derived from the Explosion: What possible Conception can be framed of two opposite *vis inertiae*, acting so as to prevent a Body for some Time from pursuing the Course of its Gravity?

On the other Hand, if the Motion Westward is *real*, it seems to imply a plain Contradiction. For no Body can really move Eastward and Westward at one and the same Time.

But tho' the Doctrine of Projectiles could be reconciled with the Motion of the Earth, yet what shall we say of self-moving Bodies? That absolute Motion which all Bodies are supposed to partake of, is not alledged to be maintained in them, after they are separated from the Earth, by any other Means than their *vis inertia*, or their retaining the Quantity of Motion once impress upon them. Now no Body
can

can move in a Direction opposite to its *vis inertia*, till that is overcome. How is it conceivable then, that Birds, for Example, after they are separated from the Earth, where they acquired their absolute Motion, should retain it at all? Certainly every Reluctation of theirs in an opposite Direction, while on the Wing, must destroy Part of their absolute Motion, as they cannot then have any fresh absolute Motion communicated to them. This should imply a great Change in the Phenomena, with Regard to the Motion of self-moving Bodies. But in Fact all the Phenomena are the same, as if the Earth were at rest. In short, the Motion which Bodies have in common with the Earth, is something which no Reaction has any Effect on. Therefore it does not, cannot depend upon the Axioms of the present Philosophy.

When we come to apply the Theory of absolute Motion to the *Secondary Planets*, in whatever Light we consider it, it becomes a Matter utterly inconceivable, nay impossible. In the first Place, we know of no absolute Motion, communicated from greater to smaller Bodies, but where they are so intimately connected, that Gravitation at last, yea soon destroys all their projectile Motion. But such is the Distance of the Moon from the Earth, and so remote is their Connexion, that her Gravitation has never gained any Thing upon her projectile Motion.

Again. The Moon, suppose her present Distance from the Earth to be her original one, could never by Means of the weak Connexion of Gravitation, correspond with the Projection of the Earth. Suppose the Moon at her present Distance, and behind the Earth, just in the Course of the Earth's Projection: In this Situation, suppose the Moon advances toward the Earth, at the Rate of sixteen Feet in a Minute, while the Earth is projected away from the Moon near a thousand Miles in the same Time: Can any one suppose, that this imperceptible Motion of the Moon toward the Earth, would draw the Moon

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out on well. and not draw it to itself. Is

with the Force of the Earth's absolute Motion? This Supposition is attended with the same manifest Impossibilities, in whatever Part of her Circle the Moon is considered, at the Moment of Projection. Suppose her in her first Quadrature: Then the Gravitation between them and the Projection of the Earth lying nearly in the same Direction, nothing could prevent their Collision in a few Hours: And till they had met, their mutual Gravitation could have no Effect in communicating the absolute Motion of the Earth to the Moon. Yet supposing that the Projection of the Moon round the Earth, commenced at the same Instant with the Projection of the Earth, does not help: For as it is not that Projection which gives the Moon her absolute Motion, the whole Impossibility remains, yea and is renewed every Month in every supposable Circumstance. For it is as impossible her absolute Motion can be maintained by such Means, as that it should commence by them.

It is no less impossible, that the Moon's absolute Motion can be owing to a Projection given to herself, than that it should be owing to her Gravitation toward the Earth, for this plain Reason; Because she has a Projectile Motion quite different from this, namely round the Earth. For nothing is more impossible, than for a Body to move in two Directions at the same Time. If five Hundred Projections, all in different Directions were applied at the same Time, the Projectile would fall into one Course, common to them all.

Add to this, that if there can be no real Motion, in an adverse Direction to absolute Motion, unless there be a Destruction, or at least weakening of that *vis inertiae*, which is supposed to be the Principle that continues absolute Motion; then the projectile Course of the Moon round the Earth, must soon destroy her absolute Motion. For every Month the Moon for near 500,000 Miles, struggles in a Course, which is in effect, diametrically opposite to the *vis inertiae*,

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carrying

carrying her in another Direction. And this cannot happen without continually weakening, and at last wholly destroying it.

For these Reasons, unless I can see them fairly removed, I must conclude, that even supposing these Principles, assumed by the present Philosophy are real, yet it is impossible to explain the celestial Motions by them."

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